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Proposal to Cease Waste Removal Activities in Tank 15 and Enter Sampling and Analysis Phase

L. B. Romanowski

Waste Disposal Authority

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Presentation Outline

- **Meeting Objective**
- **Summary/Recommendations**
- **Waste Removal History and Results**
- **Additional Cleaning Considerations**
- **Path Forward**
- **Request for Department of Energy (DOE), South Carolina Department of Environmental Services (SCDES), and Environmental Protection Agency (EPA) Concurrence**
- **Background**

Acronyms

A-P	Annulus-to-Primary	I	Iodine
BWRE	Bulk Waste Removal Efforts	LTAD	Low Temperature Aluminum Dissolution
CGCP	Consolidated General Closure Plan	LWTRSAPP	Liquid Waste Tank Residuals Sampling and Analysis Program Plan
CTS	Contingency Transfer System	MCL	Maximum Contaminant Level
DOE	Department of Energy	MSR	Mechanical Sludge Removal
DWPF	Defense Waste Processing Facility	SCDHEC	South Carolina Department of Health and Environmental Control¹
EPA	Environmental Protection Agency	SCDES	South Carolina Department of Environmental Services¹
F&B	Feed and Bleed	SLP	Standard Slurry Pump
FFA	Federal Facilities Agreement	SMP	Submersible Mixing Pump
HHW	High Heat Waste	SPF	Saltstone Production Facility
HR	Heel Removal	STP	Submersible Transfer Pump
HTF	H-Area Tank Farm	SWPF	Salt Waste Processing Facility
HW	Heel Wash	wt%	Weight Percent

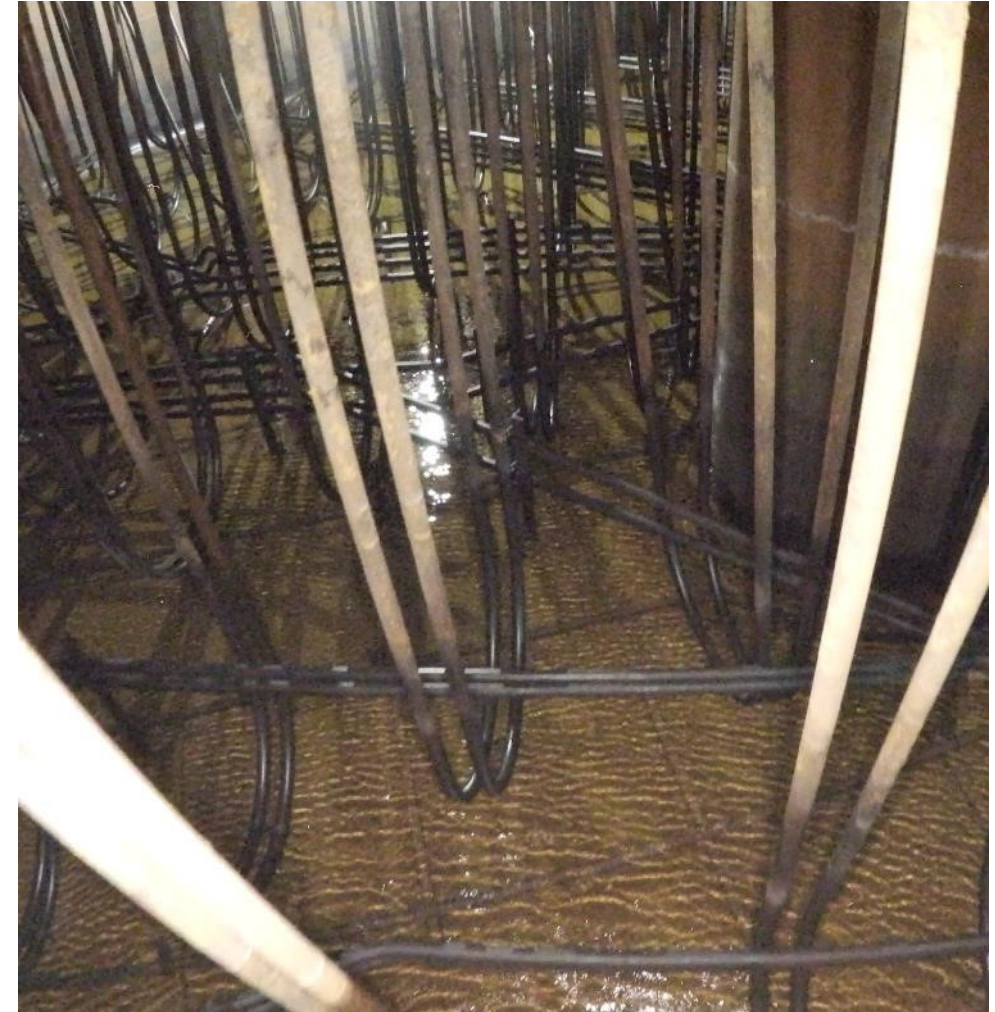
¹South Carolina Department of Environmental Services (SCDES) was known as South Carolina Department of Health and Environmental Control (SCDHEC) prior to July 1, 2024. Throughout this presentation figures and text reproduced from existing documents may still reflect SCDHEC nomenclature.

Meeting Objective

Obtain mutual agreement among DOE, SCDES, and EPA to:

1. Suspend waste removal activities in Tank 15; and
2. Enter the Sampling and Analysis phase in Tank 15 consistent with the *Consolidated General Closure Plan for F-Area and H-Area Waste Tank Systems (CGCP)* and *Liquid Waste Tank Residuals Sampling and Analysis Program Plan (LWTRSAPP)*

Tank 15 Primary



Summary

- **Over 99% of the waste volume in Tank 15 has been removed**
- **A qualitative assessment indicates that the CGCP performance objectives will not be challenged**
- **Additional waste removal in Tank 15 would have limited impact on estimated doses/performance objectives in the H-Area Tank Farm (HTF) Performance Assessment**
- **Additional waste removal activities in Tank 15 would have a negative impact on other Liquid Waste risk reduction activities**
- **A quantitative assessment utilizing final residual waste volumes and results of sampling and analysis will be included in the Closure Module covering Tank 15**
- **A formal discussion on the “practicability” of additional waste removal will be included in the Closure Module covering Tank 15**

Performance Objectives

Based on the characteristics and estimated volume of the waste remaining in Tank 15, performance objectives are expected to be met.

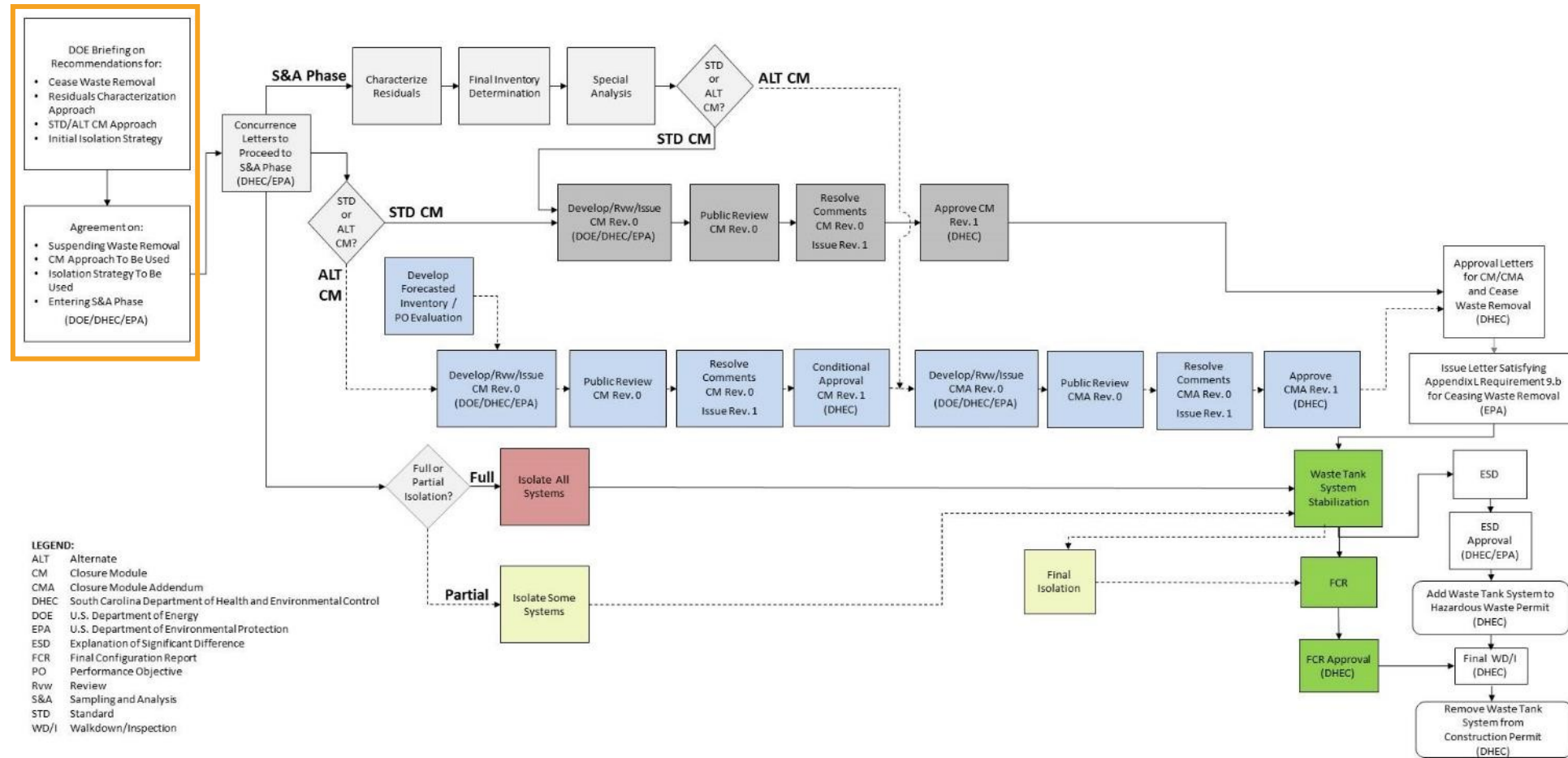
- **Anticipate that concentration values in the groundwater for HTF will be below the Maximum Contaminant Level (MCL) values for all the non-radiological inorganic constituents listed in Table 9.2-1 of the CGCP**
- **Anticipate that concentration values in the groundwater for HTF will be below the MCL values for radionuclides consistent with the State Primary Drinking Water Regulations including:**
 - *4 mrem/yr dose for beta- and gamma-emitting nuclides*
 - *15 picocuries per liter (pCi/L) for alpha-emitting nuclides (including Ra-226 but excluding radon and uranium)*
 - *5 pCi/L for radium (Ra-226 plus Ra-228)*
 - *30 micrograms per liter (µg/L) of uranium*

Radiation Dose Perspective

- **Anticipate that the peak dose from Tank 15 alone will be <6 mrem/year during both the 1,000 year and 10,000-year periods after HTF closure***
- **To put this radiological dose into perspective**
 - *Per NCRP-160, the average annual dose to a person in the United States is approximately 620 mrem primarily from:*
 - Approximately 310 mrem from naturally occurring background
 - Approximately 300 mrem from medical procedures

* Based on a preliminary estimate of the volume. Final inventories and dose impacts will be included in the Closure Module.

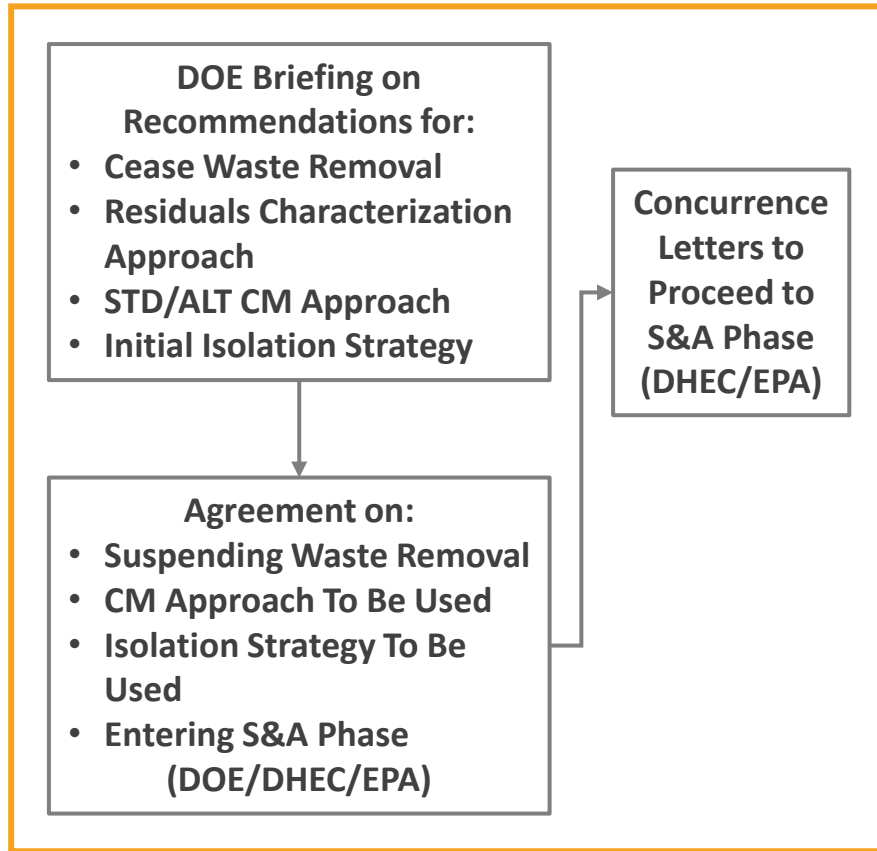
Pathway to Closure



Closure Module Approval and Waste Tank System Removal from Service Process (CGCP Figure 11.4-1)

[SRR-CWDA-2017-00015]

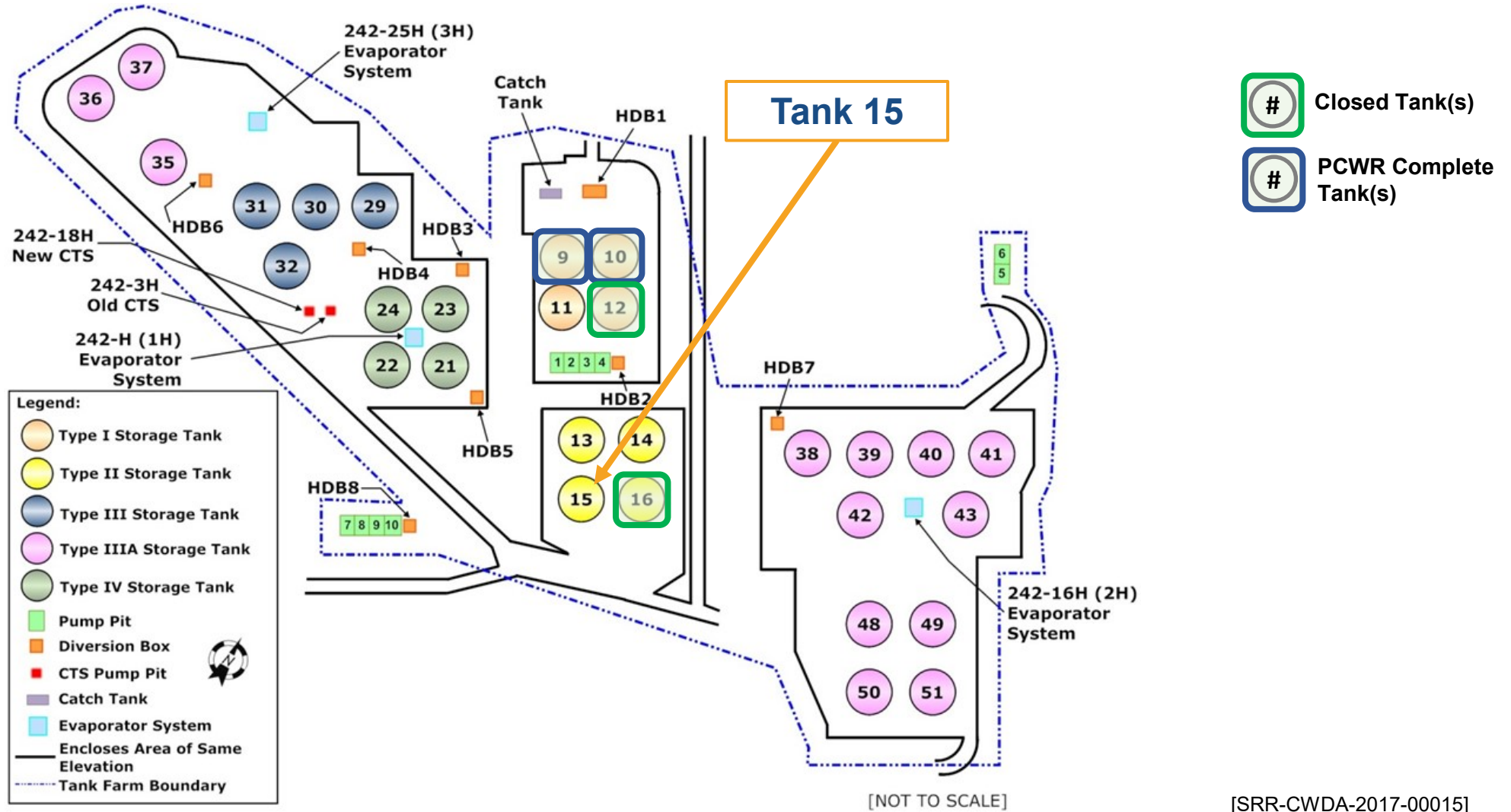
Recommendations



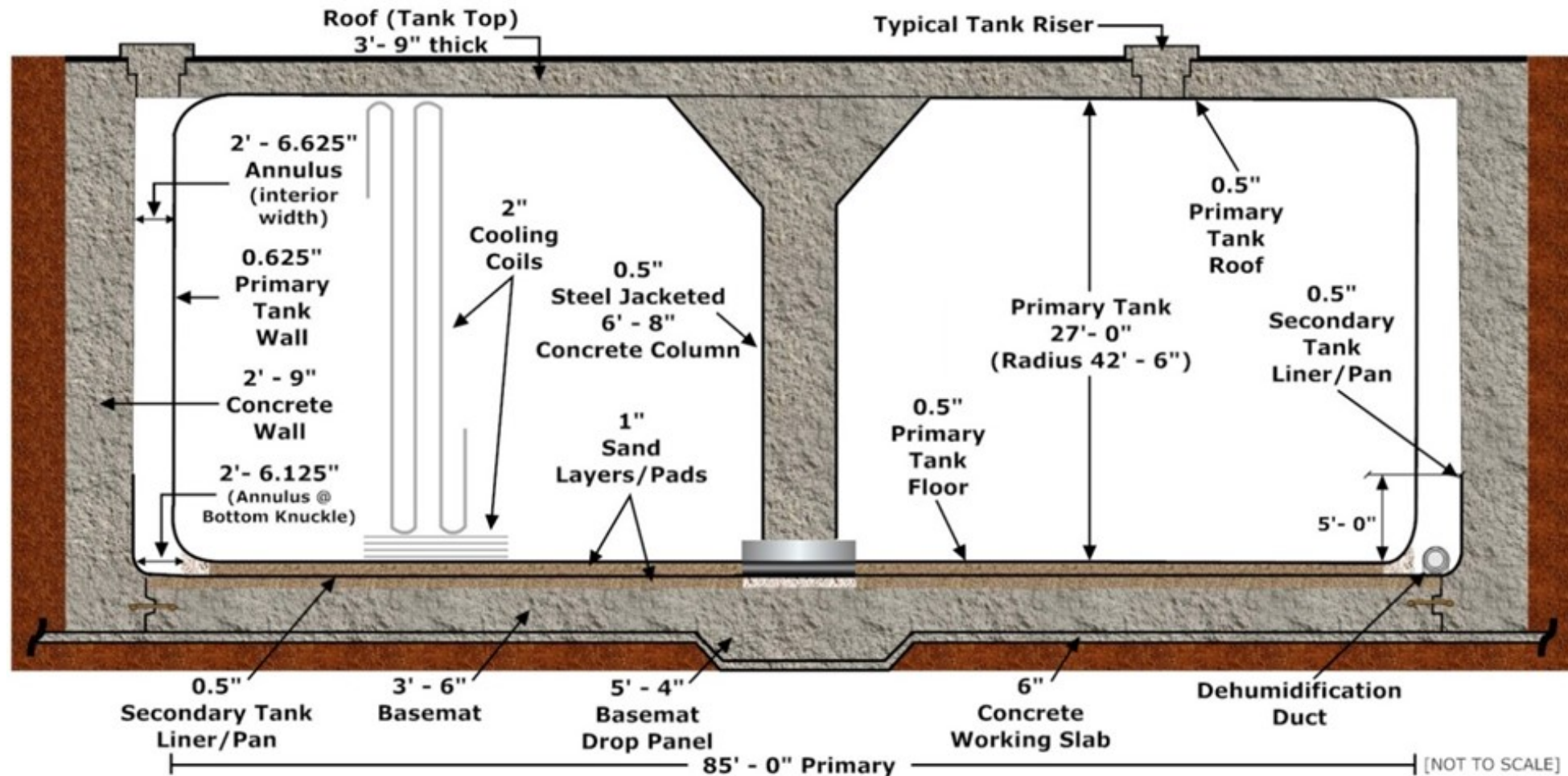
[SRR-CWDA-2017-00015]

1. **Suspending waste removal activities and enter the Sampling and Analysis phase**
 - *Sampling and analysis to be performed per the LWTRSAPP*
2. **DOE will draft a Closure Module using the *Standard Closure Module* approach**
3. **The Closure Module will include appropriate isolation and stabilization provisions using the *Partial Isolation* approach**

H-Area Tank Farm Layout



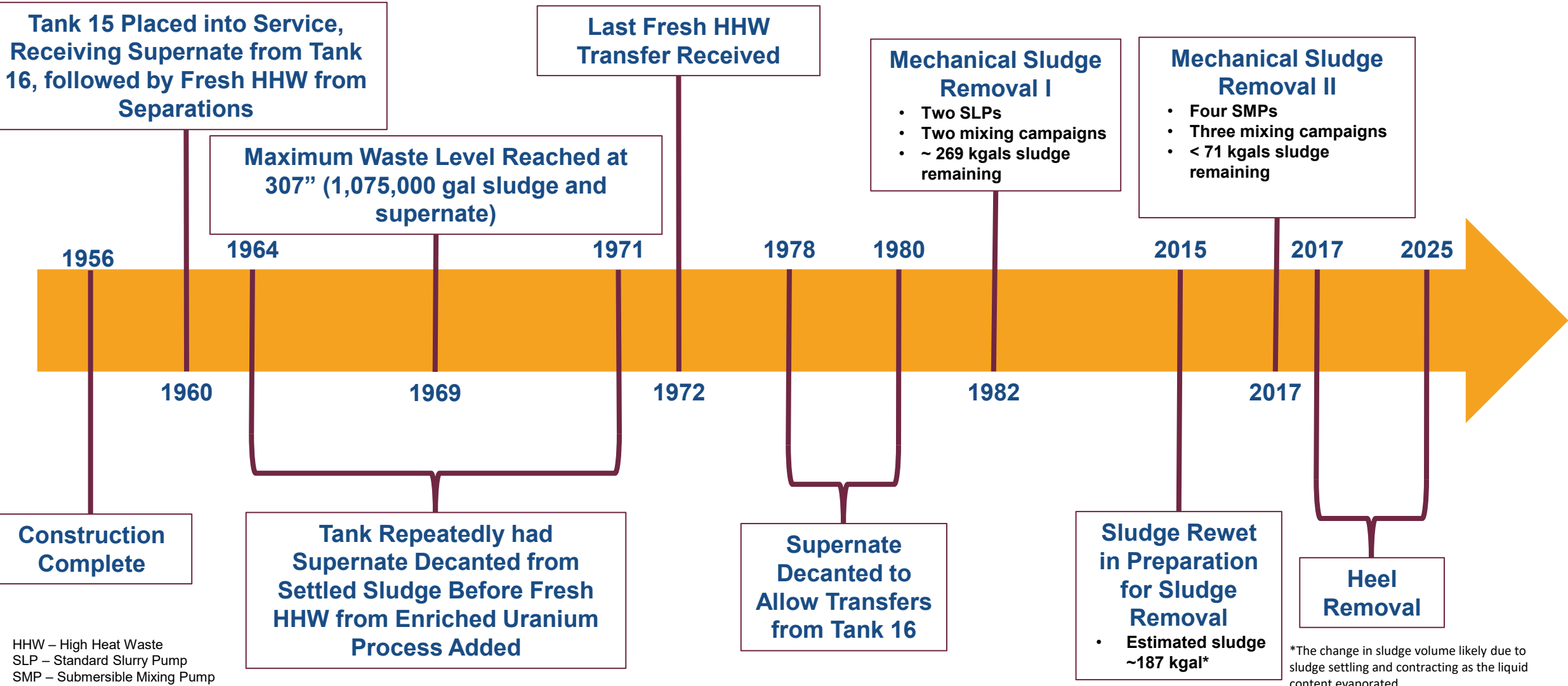
Tank 15 - Type II Tank Design



Nominal working capacity: 1,070,000 gallons
For a Type II Tank, 1" of waste equals 3,500 gallons

[SRR-CWDA-2017-00015]

Tank 15 Historical Timeline



HHW – High Heat Waste
SLP – Standard Slurry Pump
SMP – Submersible Mixing Pump

*The change in sludge volume likely due to sludge settling and contracting as the liquid content evaporated

Heel Removal Summary

Bulk Waste Removal Efforts (BWRE) were declared complete in 2017 and focus shifted to removal of the remaining heel

- Seven campaigns carried out primarily from 2022-2025 including Low Temperature Aluminum Dissolution (LTAD), heel wash (HW), and feed and bleed (F&B) campaigns
- All available Submersible Mixing Pumps (SMPs) have been deployed (total of 8 SMPs utilized since 2017)

Campaign	Date	Mixing Media Added (Kgals)	Liquid Transferred (Kgals)	Riser 2 SMP Elevation (inches)	Riser 3 SMP Elevation (inches)	Riser 4A SMP Elevation (inches)	Riser 8 SMP Elevation (inches)
1a and 1b	9/2017 - 2/2022	311 ^a	382	38	30	30	38
2	3/2023 - 6/2023	400 ^a	-	38	18	18	20
3	7/2023 - 12/2023	-	436	6	18	6	13
4	2/2024 - 3/2024	398 ^a	387	6	18	6	13
5 (LTAD)	4/2024 - 8/2024	166 ^b	189	6	18	6	13
Annulus Cleaning	9/2024	20 ^c	-	-	-	-	-
6 (HW)	10/2024-11/2024	236 ^c	265	6	18	6	13
7 (F&B)	1/2025-4/2025	440 ^c	280 ^d	6	18	6	13
Total	-	1,971	1,939	-	-	-	-

^a Supernate from Tank 13 used as mixing media

^b 108 kgals of supernate from Tank 13 used in addition to 58 kgals sodium hydroxide as mixing media

^c Water used as mixing media

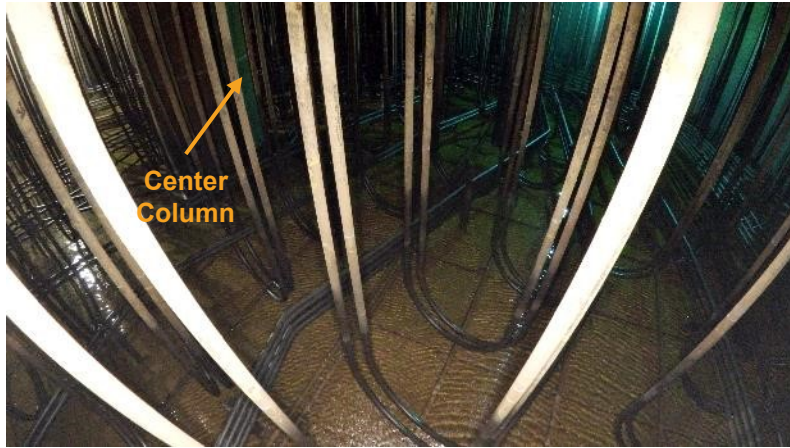
^d Volume represents final transfer volume at conclusion of F&B campaign

Tank 15 Prior to Sludge Rewet



Current Status of Tank 15

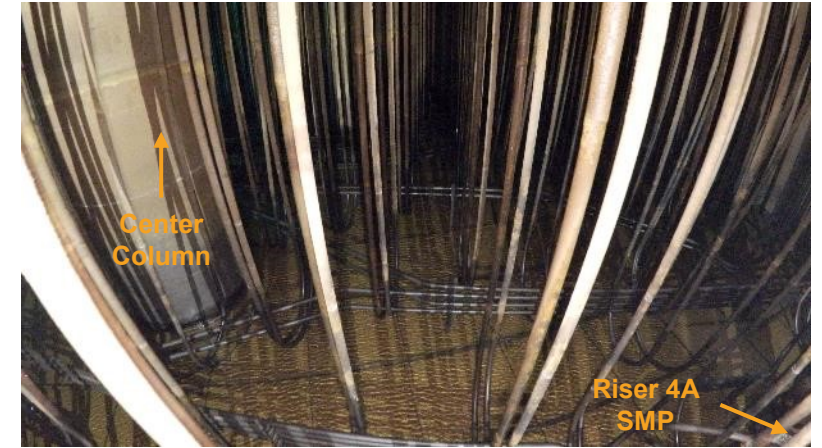
North



Northeast



East



Southeast



South



Southwest



Current Status of Tank 15

West



Coil Mound

Northwest



Coil Mound From North

Coil Mound from South



Mound Behind Riser 3



Tank 15 Annulus Cleaning

- **Four batches performed after Heel Removal Campaign 5**
 - *Each batch consisted of a water addition of ~5,000 gallons, followed by a soaking period before being pumped from the annulus to the primary tank*
- **Annulus camera inspections showed no significant change following batches three and four and annulus cleaning considered complete after the fourth batch**
- **100% annulus inspection performed after Campaign 6 to verify conditions throughout**
 - *Inspection of annular pan showed cleaning effectiveness consistent in all areas*
 - *Minimal salt accumulations were observed on the primary tank wall from previous leak sites*
 - *As free liquid dries up, some residual material evident within the annulus pan/ventilation duct. Residual material estimated to be less than four inches on average*

Tank 15 Annulus Cleaning

IP-107 Before/After



IP-207 Before/After



Overall Cleaning Results

Maximum Waste Volume (gal)	1,075,000
Maximum Sludge Volume (gal)	389,000
Total Solids Remaining (gal)	<6,000 ¹
Total Waste Remaining (gal)	<7,800 ²

¹ Based on a preliminary estimate of the solids remaining in the primary. Final volume determination will be included in the Closure Module.

² Based on a preliminary estimate of the primary plus annulus. Final volume determination will be included in the Closure Module.

Total Percent Waste Removed Greater than 99%

Additional Removal Options

• Mechanical Cleaning

- *Traditional mixing campaigns using supernate in Tank 15 have shown diminished effectiveness on the remaining material.*
- *Each new washing campaign requires a minimum of approximately 200K gallons of water be added to Tank 15 to allow for mixing pump operation, creating additional new waste*
 - Additional new waste must be handled within the Liquid Waste System which is already challenged by available tank space to support Salt Batch compilation/qualification and Sludge Batch compilation/qualification necessary to feed Salt Waste Processing Facility (SWPF) and the Defense Waste Processing Facility (DWPF), respectively
 - Additional new waste must be processed through SWPF then subsequently DWPF or the Saltstone Production Facility (SPF), resulting in additional costs and impacts (i.e., extension) to the Liquid Waste System life-cycle
- *Each new mixing or washing campaign would divert resources (i.e., funding and personnel) from other Liquid Waste System risk reduction activities*
 - Funding and resources could be used to accelerate waste removal on other waste tanks
- *Level of additional waste removal uncertain, but even removing the majority of the remaining material, if possible, would have a limited impact on final performance objective concentrations and doses*

Additional Removal Options

• Chemical Cleaning

- *Additional chemical cleaning would divert resources (i.e., funding and personnel) from other Liquid Waste System risk reduction activities*
 - Funding and resources could be used to accelerate waste removal on other waste tanks
- *Any chemical cleaning campaign would require approximately 200k gallons of water/chemicals be added to Tank 15 to allow for mixing pump operation, creating additional new waste*
 - Additional new waste must be handled within the Liquid Waste System which is already challenged by available tank space to support Salt Batch compilation/qualification and Sludge Batch compilation/qualification necessary to feed SWPF and DWPF, respectively
 - Additional new waste must be processed through SWPF then subsequently DWPF or SPF, resulting in additional costs and impacts (i.e., extension) to the Liquid Waste System life-cycle
- *Level of additional waste removal uncertain, but even removing the majority of the remaining material, if possible, would have a limited impact on final performance objective concentrations and doses*
 - Effectiveness of additional LTAD campaign(s) uncertain
 - Bulk Oxalic Acid cleaning would have additional adverse impact of introduction of additional oxalates into the system

Additional Removal Options

• Vacuum Technology

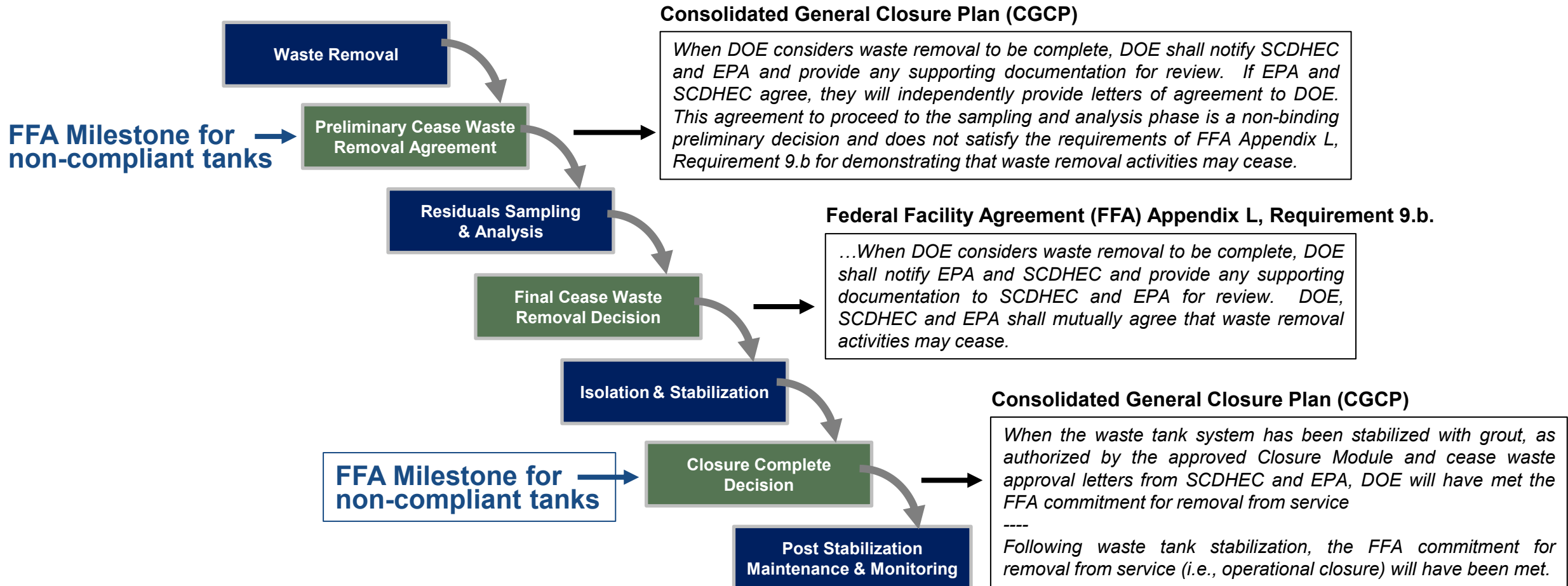
- *Proven Mantis technology that was utilized in Tanks 18 and 19 cannot be deployed due to in-tank obstructions*
- *Alternate technology utilizing a smaller robotic platform with vacuum capability would require considerable development*
 - Very limited applicability at the time due to mobility around and over in-tank obstacles and associated tether management
 - Any water added to support removal, if required, would result in new waste and have same impact as previously described for additional mixing campaigns and chemical cleaning
 - Development/deployment of a new vacuum technology would divert resources (i.e., funding and personnel) from other Liquid Waste System risk reduction activities
- *Level of additional waste removal uncertain, but even removing the majority of the remaining material, if possible, would have limited impact on final performance objective concentrations and doses*

Additional Removal Options

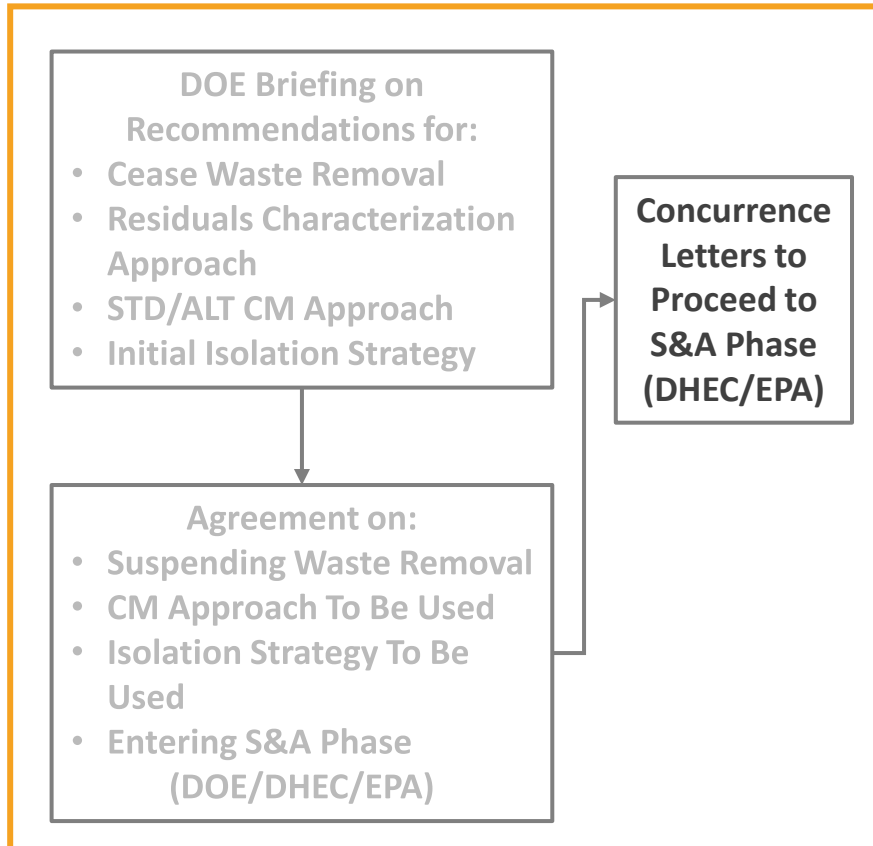
- **Additional annulus waste removal**

- *Based on results from annulus inspections and amount of material that may be remaining on the annulus pan floor or in the ventilation duct, additional water addition/removal campaigns would be expected to have minimal impact on performance objectives while generating additional new waste into the Liquid Waste System and delaying other Liquid Waste System risk reduction activities*
- *Doses/concentrations associated with waste remaining within the annulus of Tank 15 are expected to contribute just a small portion to the overall doses/concentrations associated with all the waste remaining within the tank*
 - Removing even the majority of the remaining material within the annulus, if possible, would be expected to have a minimal impact on final performance objective concentrations and doses

Tank Closure Process



Requested Action



[SRR-CWDA-2017-00015]

The three agencies agree that, based upon the described qualitative assessment, **there is reasonable assurance** that it is appropriate to suspend waste removal activities and enter the **Sampling and Analysis** phase of the operational closure process for **Tank 15**

Next Steps

- **DOE will forward a letter to SCDES and EPA formally requesting concurrence to proceed to the Sampling and Analysis phase in Tank 15**
 - *This presentation will be attached as a primary reference*
 - *The requested action is a non-binding preliminary decision based on the qualitative information available at this time and presented today*
- **DOE and the Liquid Waste Contractor will proceed in developing the regulatory documentation necessary to operationally close Tank 15**
 - *DOE will coordinate with SCDES and EPA to establish a schedule for the development, review and approval of the Closure Module consistent with the approach described in the CGCP*

Common Goals & Values*

Values

1. Maintain transparency with open communication between regulators, DOE, and the contractor on program progress, and significant emerging issues.
2. Ensure DOE's strategy and plans are subject to stakeholder engagement and input, including SCDHEC permitting processes, and CERCLA, as appropriate.
3. Maximize the amount of curies (especially long-lived radionuclides) vitrified and ready for ultimate disposal out of state.
4. Limit disposal of curies onsite at SRS so that residual radioactivity is as low as reasonably achievable.

Goals

1. Reduce risk to the environment by removing waste and closing tanks with a goal of completion of the liquid waste program by 2037.
2. Reduce operational and environmental risk by aggressively removing curies from the waste tanks.
3. Reduce operational and environmental risk by optimizing operations to minimize liquid waste program total life cycle.
4. Complete waste removal and subsequent grouting of all waste tanks and ancillary structures with a risk-based priority order: **first to tanks in the water table**, followed by F Tank Farm tanks, followed by remainder of waste tanks, followed by ancillary structures, recognizing the potential for future emergent conditions or opportunities.

**From Federal Facility Agreement (FFA) 2022 High Level Waste Tank Milestones Agreement [WSRC-OS-94-42]*

Summary for Closed/PCWR Complete Tanks

Waste Tank	PCWR Date	Operational Closure Date	Max. Dose within 10,000 years ¹ (mrem/yr)	Primary Tank Residual Solids Volume ² (%)	Primary Tank Residual Solids Volume (Gallons)	Annulus Residual Volume (Gallons)	Annulus Cleaning
4 ³	12/2024	-	<5	<1	<6,000	Negligible	No - negligible
5	11/2010	12/2013	3	0.26	1,900	<15	No – negligible
6	11/2010	12/2013	3	0.41	3,000	<50	Yes ~ 100 gal
9 ³	10/2024	-	<3	<1	<7,500	Negligible	Yes
10 ³	5/2024	-	<2	<0.40	<3,000	<400	Yes
12	1/2014	4/2016	6	0.20	1,500	30	No – negligible
16	4/2013	9/2015	2	0.21	356	1,910	No – not practical
17	N/A	12/1997	3	0.18	2,400	N/A	N/A
18	10/2009	9/2012	3	0.30	3,900	N/A	N/A
19	10/2009	9/2012	3	0.15	2,000	N/A	N/A
20	N/A	7/1997	3	0.08	1,000	N/A	N/A

¹ Dose for closed FTF tanks represents maximum all sources dose utilizing actual inventories for Tanks 5, 6, and 17 – 20. Dose for other tanks represents maximum contribution from individual tanks. [SRR-CWDA-2012-00106, SRR-CWDA-2015-00073, SRR-CWDA-2014-00106]

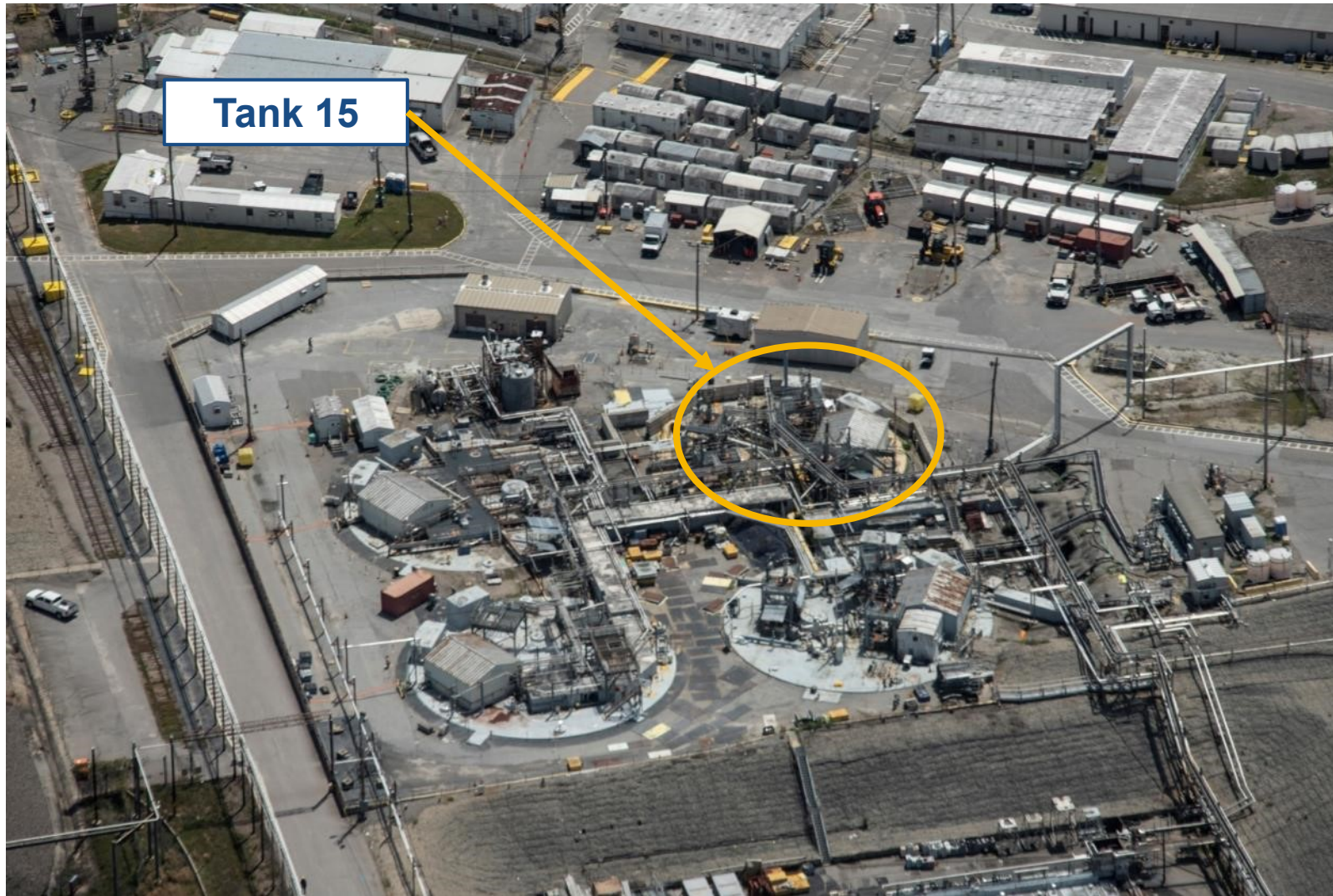
² Based on historic maximum waste volume for each tank. [DOE/SRS-WD-2012-001, DOE/SRS-WD-2014-001]

³ Values based on preliminary information, sampling and analysis has not been performed

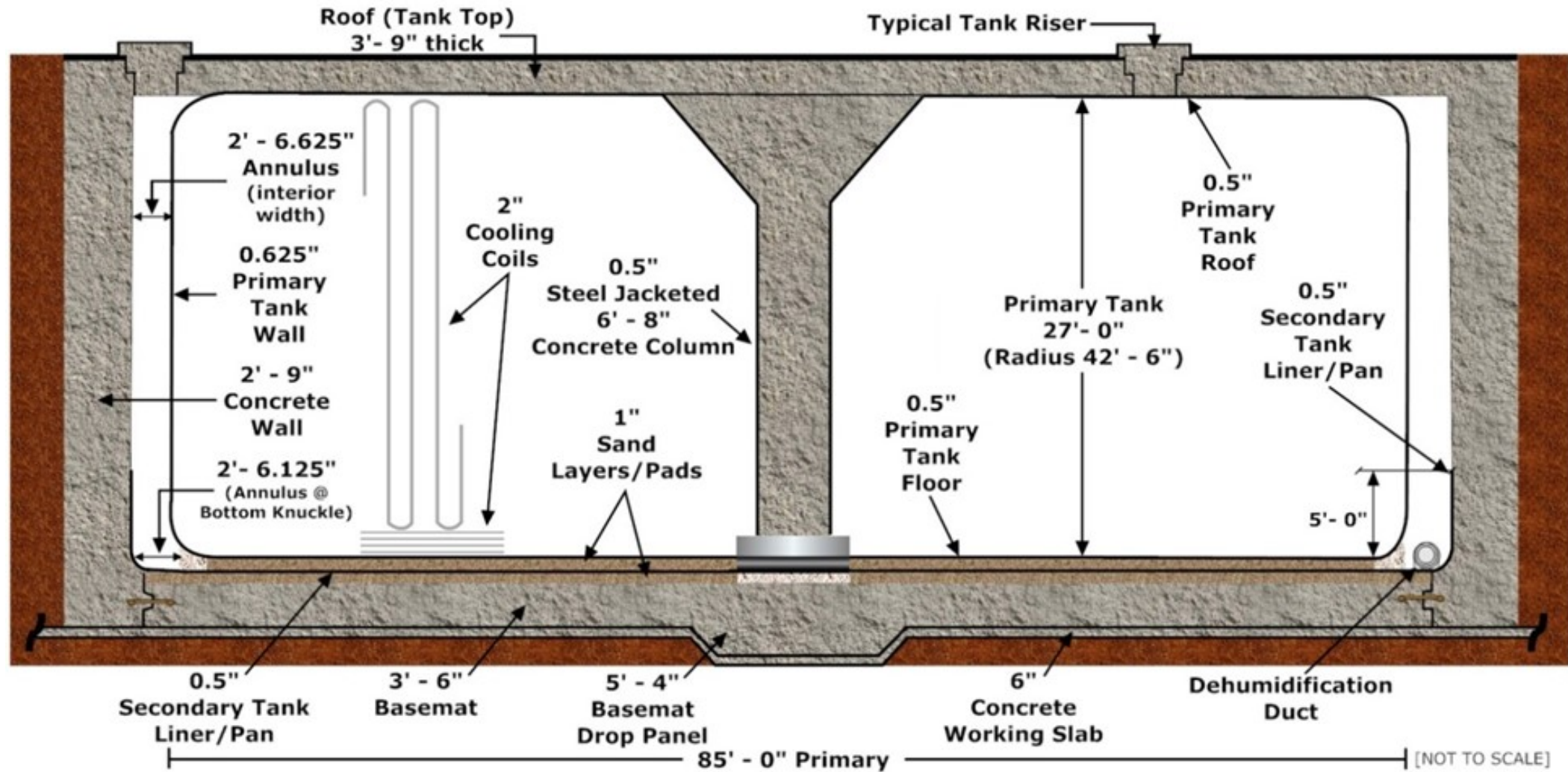
Tank 15

Background Information

Tank 15 Within H-Area Tank Farm



Tank 15 - Type II Tank Design



[SRR-CWDA-2017-00015]

Tank 15 - Type II Tank Design

- Carbon steel primary tank and secondary liner (annular pan) all contained in a concrete vault
- Nominal tank capacity: 1,070,000 gallons
- For a Type II Tank, 1” of waste equals 3,500 gallons
- Primary tank diameter: 85 feet
- Primary tank height: 27 feet
- Annular pan diameter: 90 feet
 - *2-foot 6.625-inch annular space surrounding primary*
- Annular pan height: 5 feet
- One central support column
 - *6-foot 8-inch diameter*
- 40 vertical cooling coils supported by rods welded to the roof and floor
- 4 horizontal cooling coil runs supported above the floor

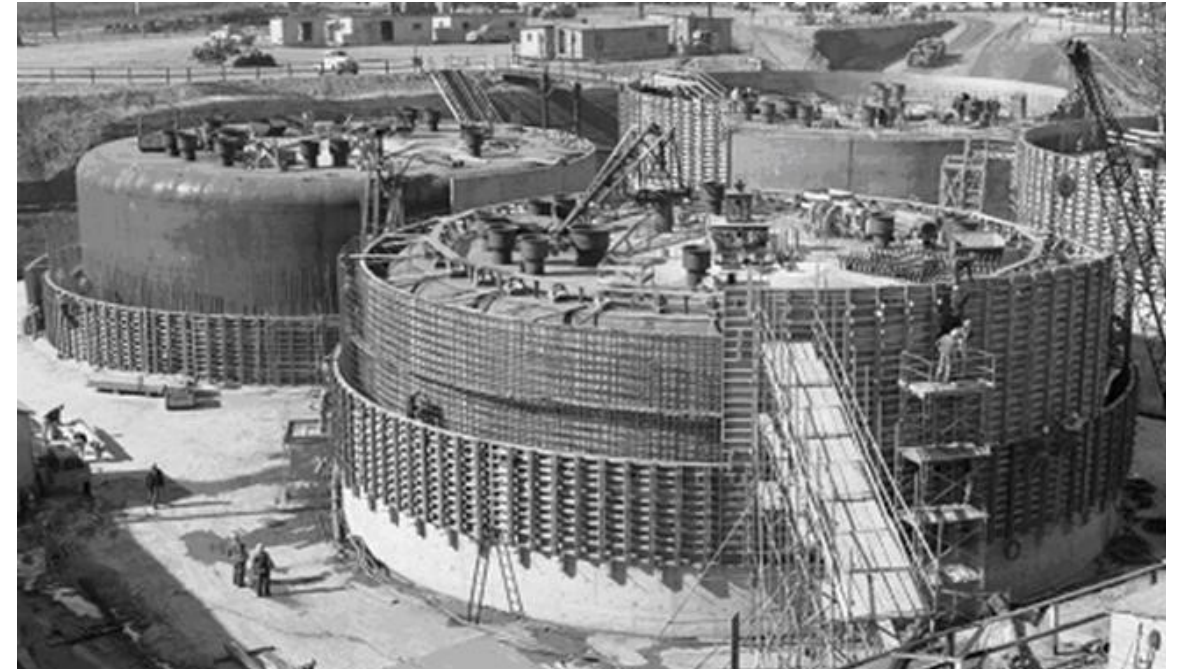
[SRR-CWDA-2017-00015]

HTF Type II Tank Construction

Type II Tank – Early Stage of Vault Construction



Type II Tank – Late Stage of Vault Construction



Typical Type II Tank Challenges

- **Challenges include:**
 - *Limited access ports (risers)*
 - *Approximately 29,400 linear feet of 2-inch diameter vertical and horizontal cooling coils*
 - *“Field-to-fit” horizontal cooling coil “fences”*
- **Tanks were not designed with waste removal in mind**

Type II Tank Riser Limitations

- **Primary access**

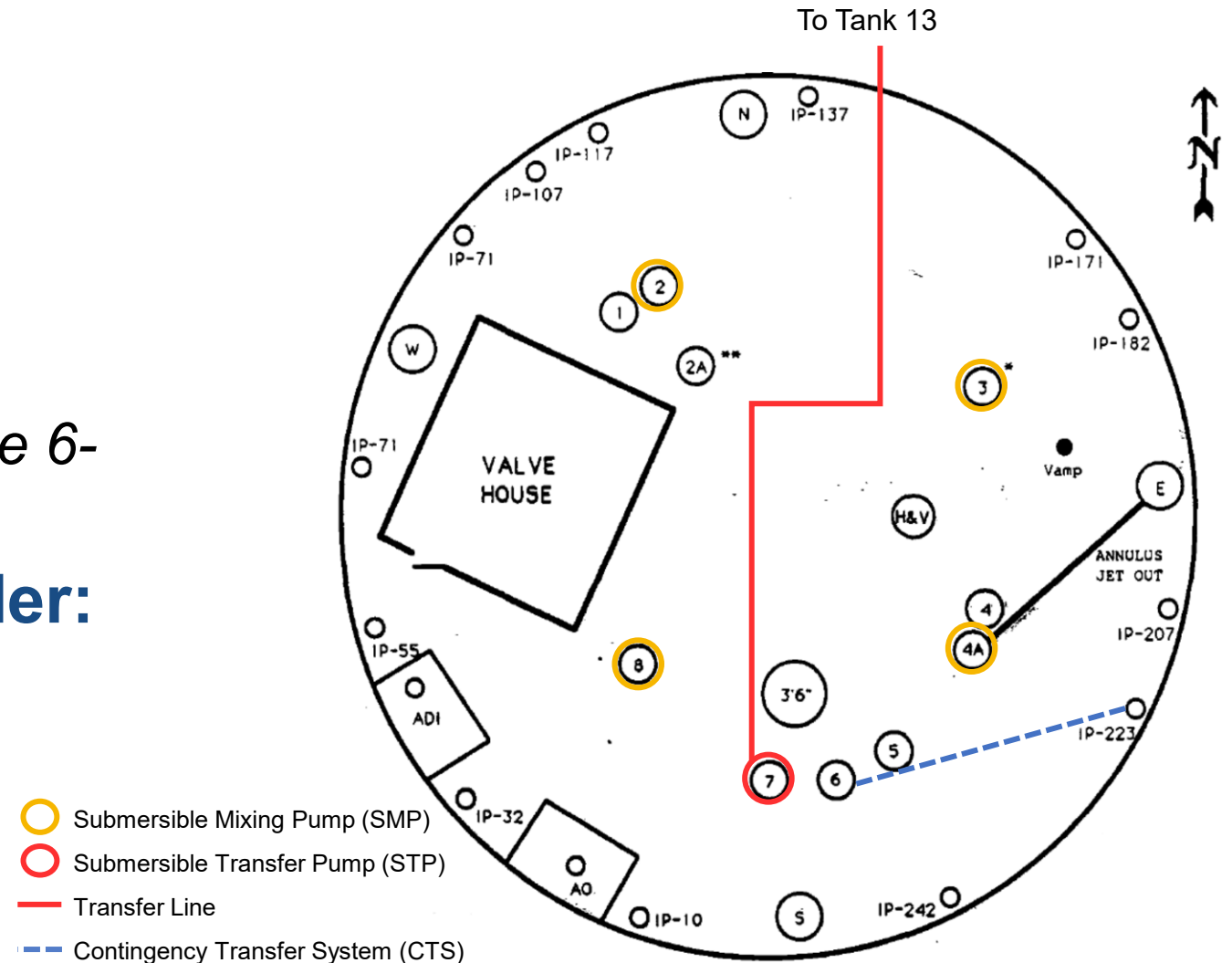
- Ten 24-inch risers
- One 42-inch riser

- **Annulus access**

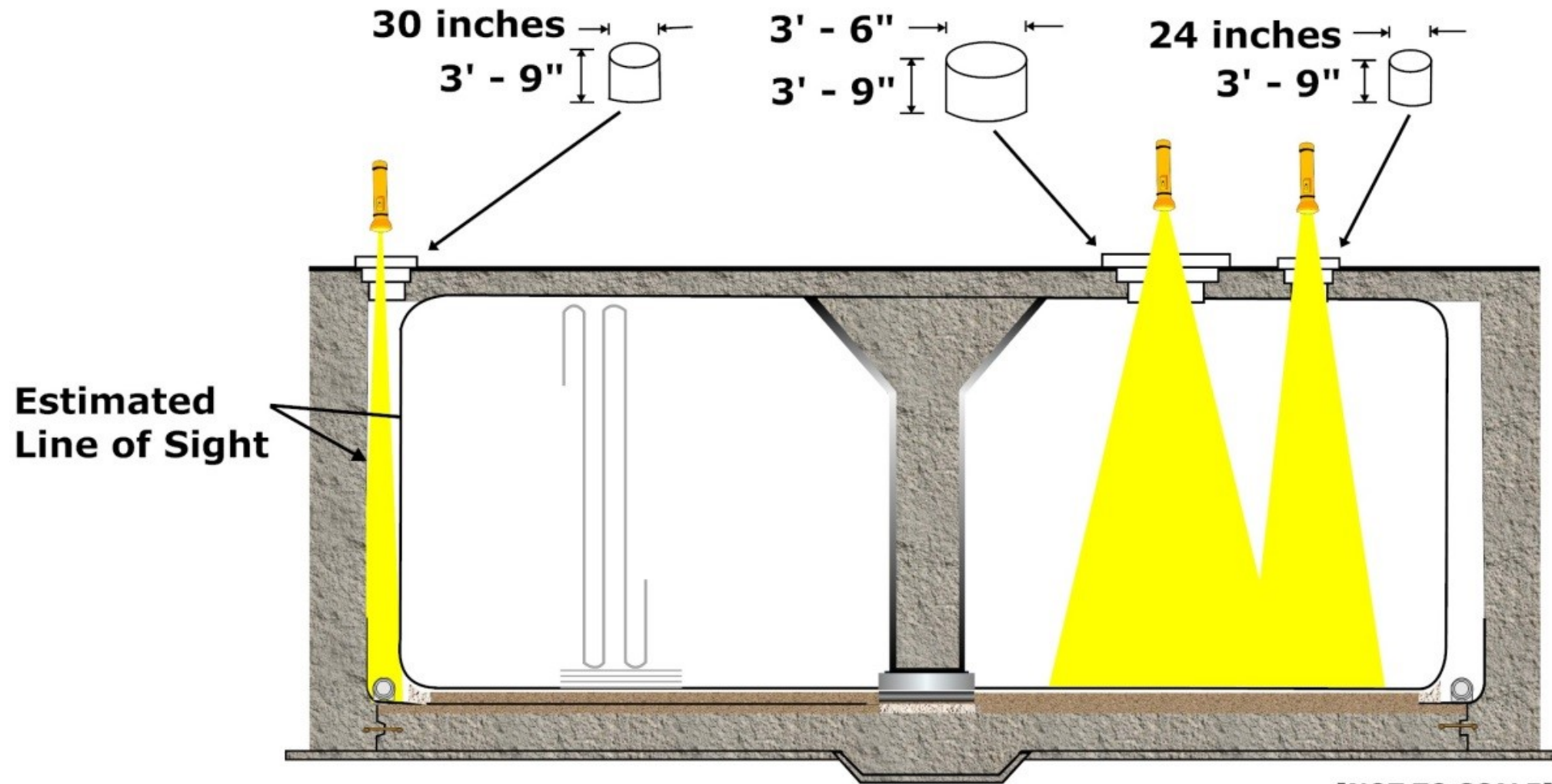
- Four 30-inch risers
- Tank 15 has an additional twelve 6-inch risers

- **Limited riser entrances hinder:**

- Pump placement
- Cleaning operations
- Camera viewing
- Sampling options



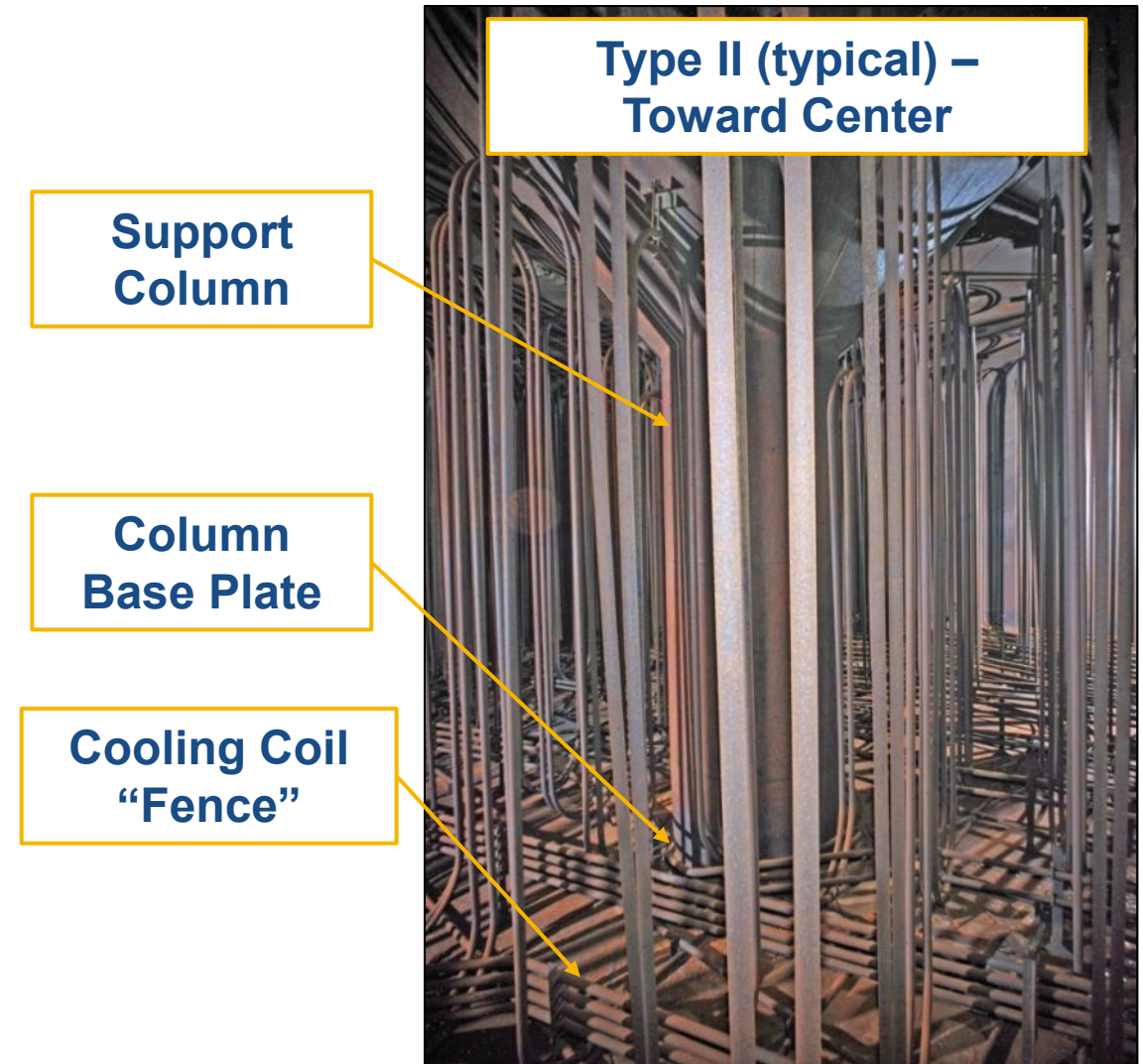
Type II Tank Riser Limitations



[NOT TO SCALE]
[SRR-CWDA-2017-00015]

Type II Tank Columns and Cooling Coils

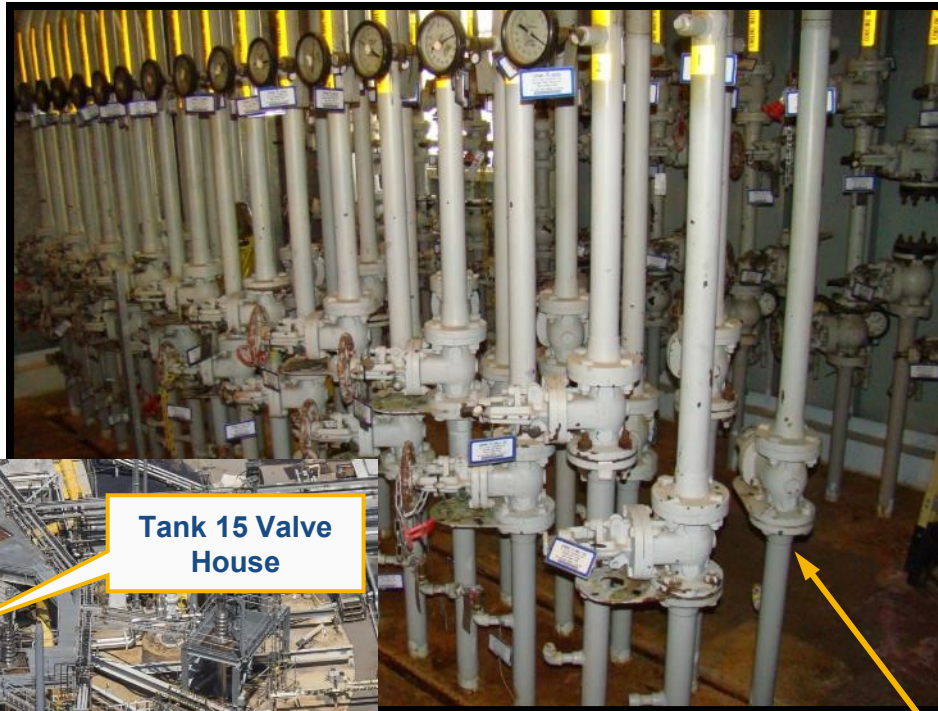
- **One central support column**
 - *Carbon steel reinforced with rebar and filled with concrete*
 - *6-foot 8-inch diameter*
 - *4-inch thick steel base plate*
- **Type II tanks contain approximately 29,400 linear feet of 2-inch diameter cooling coils**
- **Horizontal coils were installed “field-to-fit”**
- **Columns and cooling coils together impact installation and/or operation of waste removal related equipment**
 - *Effective cleaning radius of pumps*
 - *Full installation of pumps*
 - *Sampling device deployment*



Cooling Coil Valve House

Valve House Interior

View From Inside Tank (Under the Valve House)

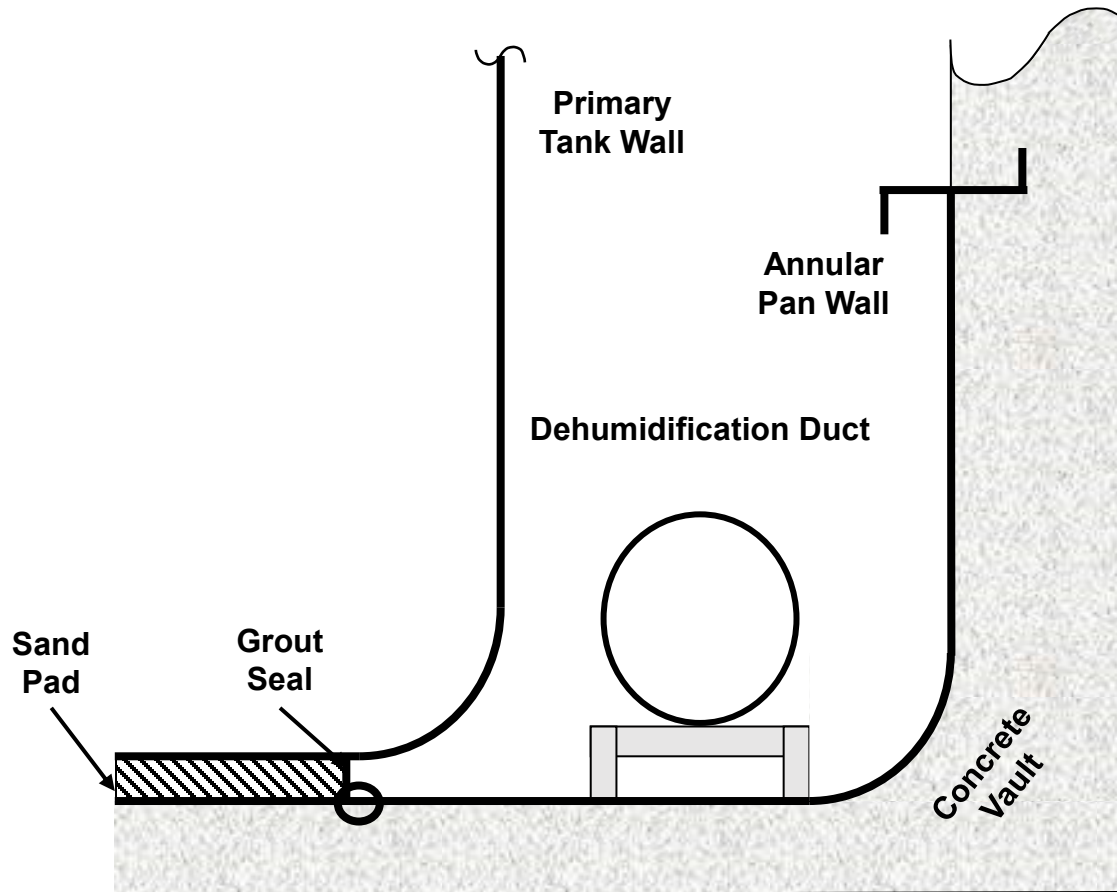


Example shown is from a Type I tank. Similar arrangement in Type II waste tanks

Cooling coil lines entering and exiting waste tank

Type II Tank Annular Region

5-foot high, 90-foot diameter annular pan provides secondary containment

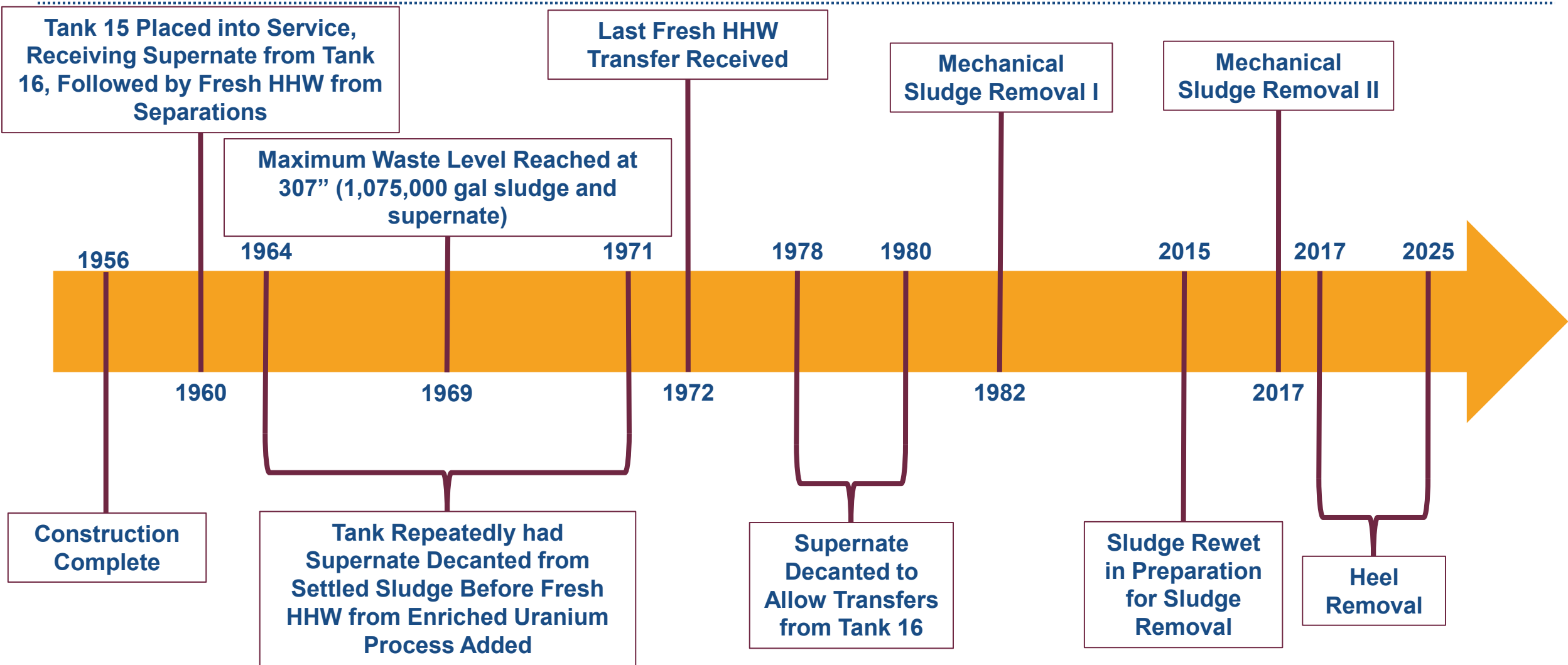


Tank 15 Operational History

- **Constructed between 1955 and 1956**
- **Beginning in 1960 received supernate from Tank 16 before receiving fresh HHW from H-Canyon through 1961**
- **A series of supernate decants were performed from 1964 to 1972 to allow for more HHW receipts**
 - *~3,700,500 gallons transferred out of Tank 15 over six decants*
 - *Transfers stopped with the discovery of leak sites into the annulus*
 - *~270" waste remained*
- **Maximum historical waste level in 1969**
 - *307"*
- **Supernate was again decanted to allow two transfers from Tank 16 between 1978 and 1980**
 - *~230" or ~800,000 gallons of waste left in Tank 15*

[DPSPU-77-11-26, WSRC-TR-98-00373]

Tank 15 Historical Timeline



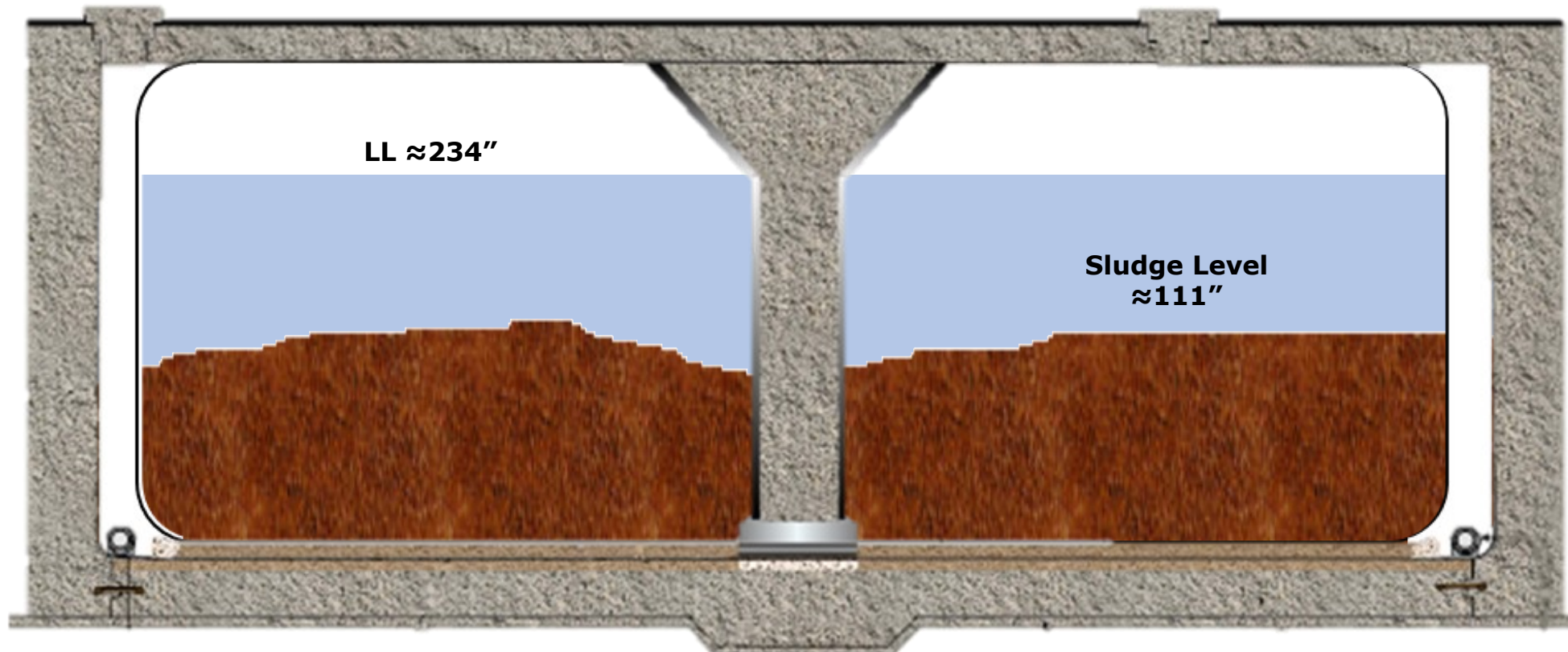
HHW – High Heat Waste

Waste Removal History – Starting Condition

- **Maximum historical waste level in 1969**
 - *307” or 1,075,000 gallons sludge and supernate combined*
- **At conclusion of H-Canyon HHW receipts in 1972, contained 322,000 gallons of sludge solids**
- **Additional 67,000 gallons of sludge received from Tank 16 in 1979**
- **Maximum sludge volume was approximately 389,000 gallons in 1979 before waste removal efforts began**

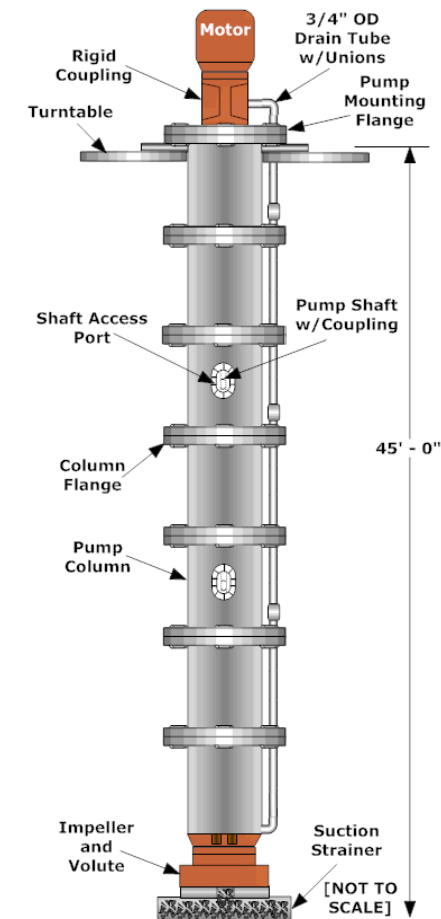
Mechanical Sludge Removal I

Tank 15 Before the Start of Mechanical Sludge Removal I
(1979)



Mechanical Sludge Removal I

- In 1982 two standard slurry pumps (SLPs) used for Mechanical Sludge Removal (MSR) I – Campaigns 1 and 2
- Approximately 125,000 gallons of sludge (as 704,000 gallons of sludge slurry) were transferred out of Tank 15
- At the conclusion of MSR I, Tank 15 estimated to have approximately 269,000* gallons of sludge remaining

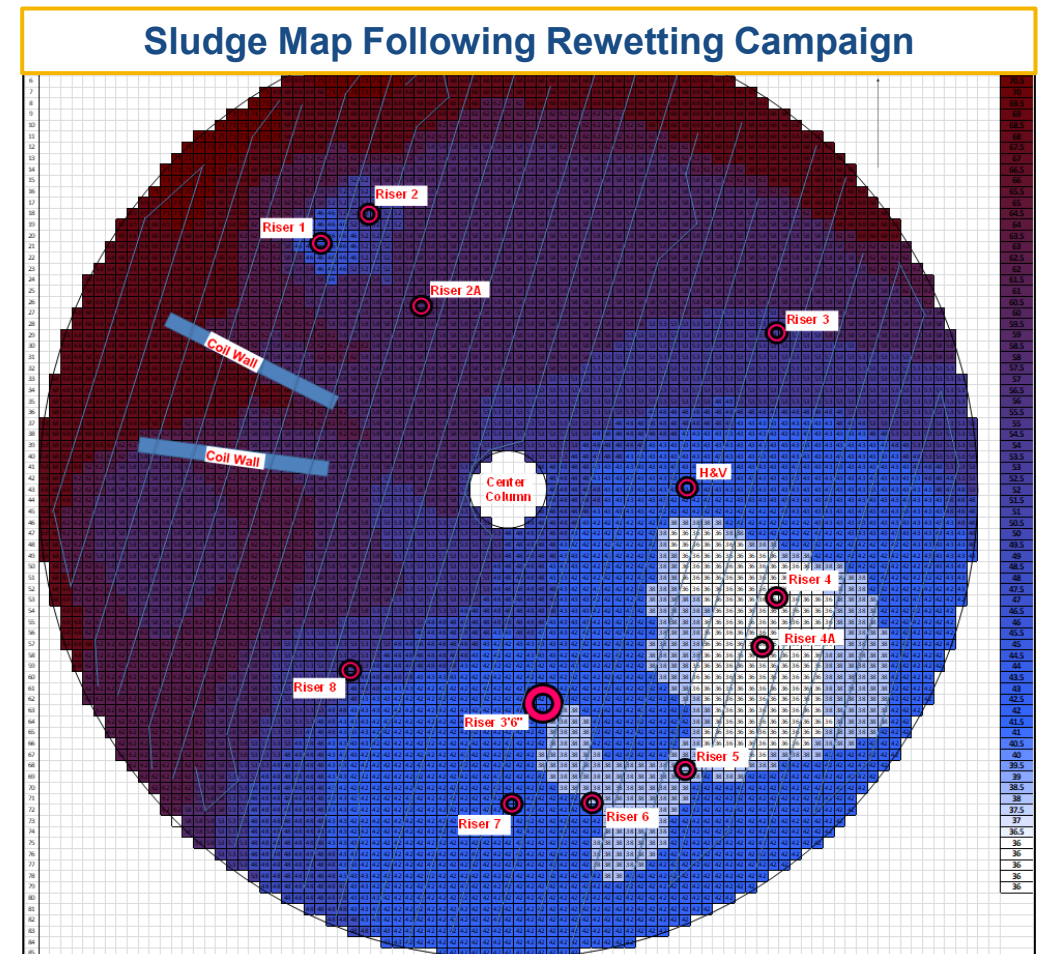


*Values come from historical documentation and should be considered approximate. Variation in total volumes exist (i.e., 389,000 gallons – 125,000 gallons = 264,000 gallons)

[DPSP-82-21-3. DPSP-83-17-3]

Evaporation and Rewetting

- After MSR I, there were no transfers in or out of Tank 15
- From 1983 – 2015 the supernate above the solids and the interstitial liquid within the sludge were allowed to evaporate
 - Due to evaporation, the sludge volume contracted
- In 2015, approximately 184,000 gallons of inhibited water and sodium nitrate solution added to rewet the now dried sludge
 - A mapping conducted during this rewetting campaign estimated Tank 15 contained approximately 187,000* gallons of sludge



*The change in sludge volume from 1982 (269,000 gallons) to 2015 (187,000 gallons) is most likely due to sludge settling and contracting as the liquid content evaporated

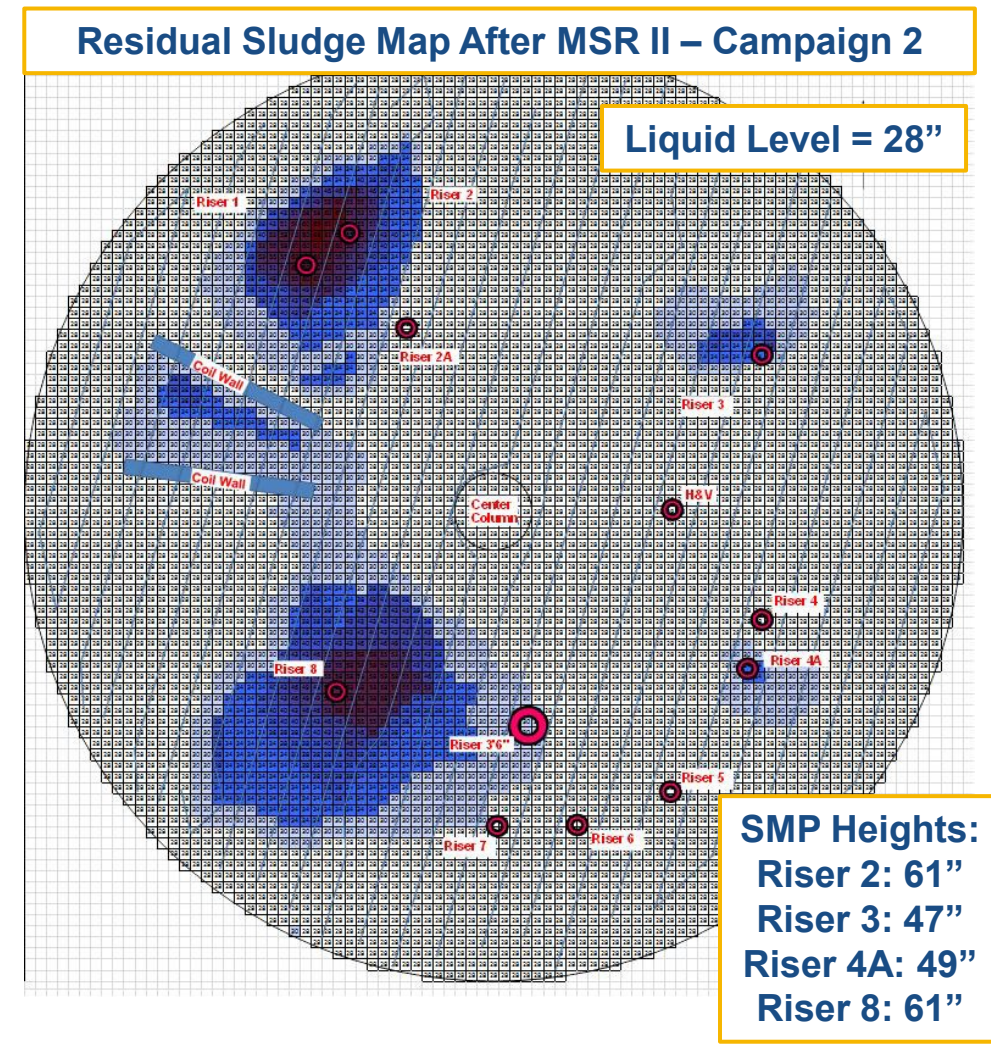
[SRR-CWDA-2017-00062, U-ESR-H-00130]

MSR II – Preparations

- **In preparation for future campaigns changes were made to Tank 15 to incorporate lessons learned**
 - *Four SMPs were installed*
 - Provide additional mixing power and placement of an SMP in each quadrant increased effective cleaning radius
 - *Additional alarms and interlocks installed to reduce SMP failure risk due to blockage of intake screens*
 - *Modifications to address mercury hazards and to protect HEPA filters were installed*
 - *Leak tests were performed to allow for the use of additional cooling coils near the SMPs in order to meet temperature requirements*
- **Began Campaign 1 in October 2016**

MSR II – Campaign 2

- SMPs in Risers 2 and 3 as well as the transfer pump in Riser 7 were lowered prior to mixing
- SMPs were run for 366 hours
- Transfer from Tank 15 to Tank 13 completed on April 2, 2017
- Sludge slurry transferred weight percent insoluble solids estimated to be ~4%
- Approximately 40,000 gallons sludge estimated to have been removed, leaving a bounding sludge volume of 105,000 gallons

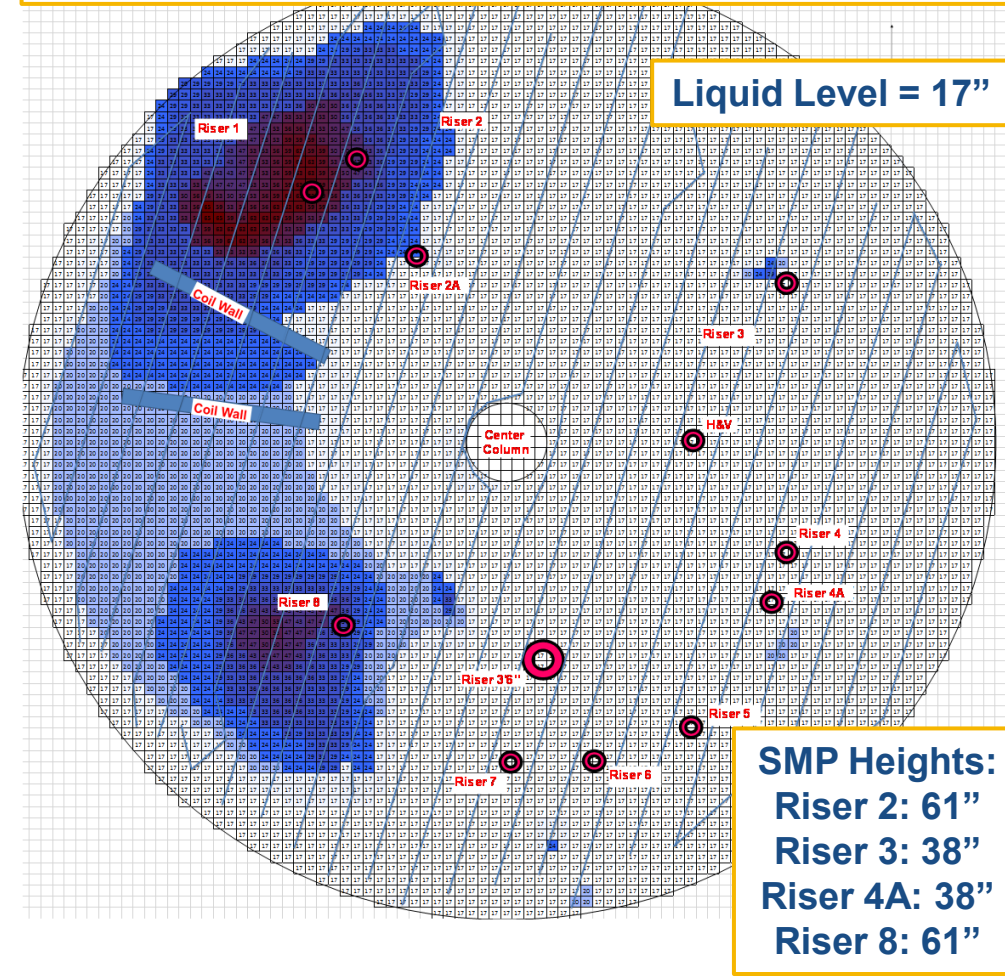


[SRR-CWDA-2017-00062, U-ESR-H-00151 Rev. 4, U-ESR-H-00161]

MSR II – Campaign 3

- SMPs in Risers 3 and 4A as well as the transfer pump in Riser 7 were lowered prior to mixing
- SMPs were run for 414 hours, including 4 days of indexing runs aimed at mounds beneath Risers 2 and 8 prior to a 10-day oscillation campaign
- Transfer from Tank 15 to Tank 13 completed on June 28, 2017
- Sludge slurry transferred weight percent insoluble solids estimated to be ~2%
- Approximately 34,000 gallons sludge estimated to have been removed, leaving a bounding sludge volume of 71,000 gallons

Residual Sludge Map After MSR II – Campaign 3



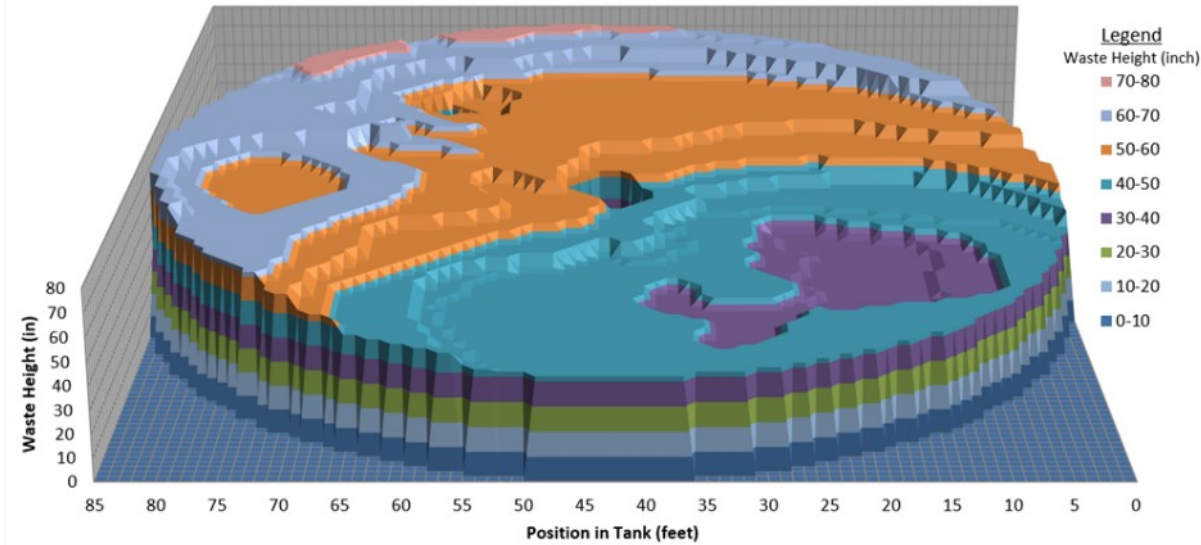
[SRR-CWDA-2017-00062, U-ESR-H-00151 Rev. 4, U-ESR-H-00161]

MSR II - Conclusion

- **MSR II campaigns were very effective; removed at least 116,000 gallons of sludge**
- **As MSR II progressed, each subsequent transfer showed a significant decrease in solids actually being transferred (weight % insoluble solids)**
- **Bounding estimate of sludge solids remaining at the conclusion of MSR II was 71,000 gallons and conservatively assumed that the volume underneath the liquid level was all sludge**
- **A resilient mound under and around Riser 2 persisted and remained a primary source of solids in the tank**

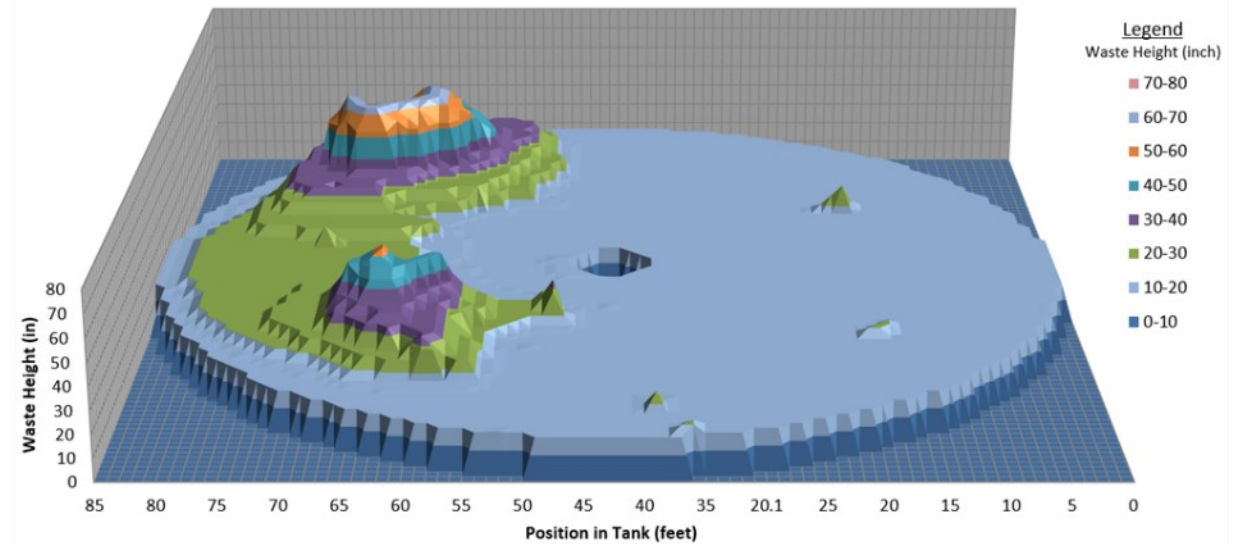
[SRR-CWDA-2017-00062]

MSR II - Conclusion



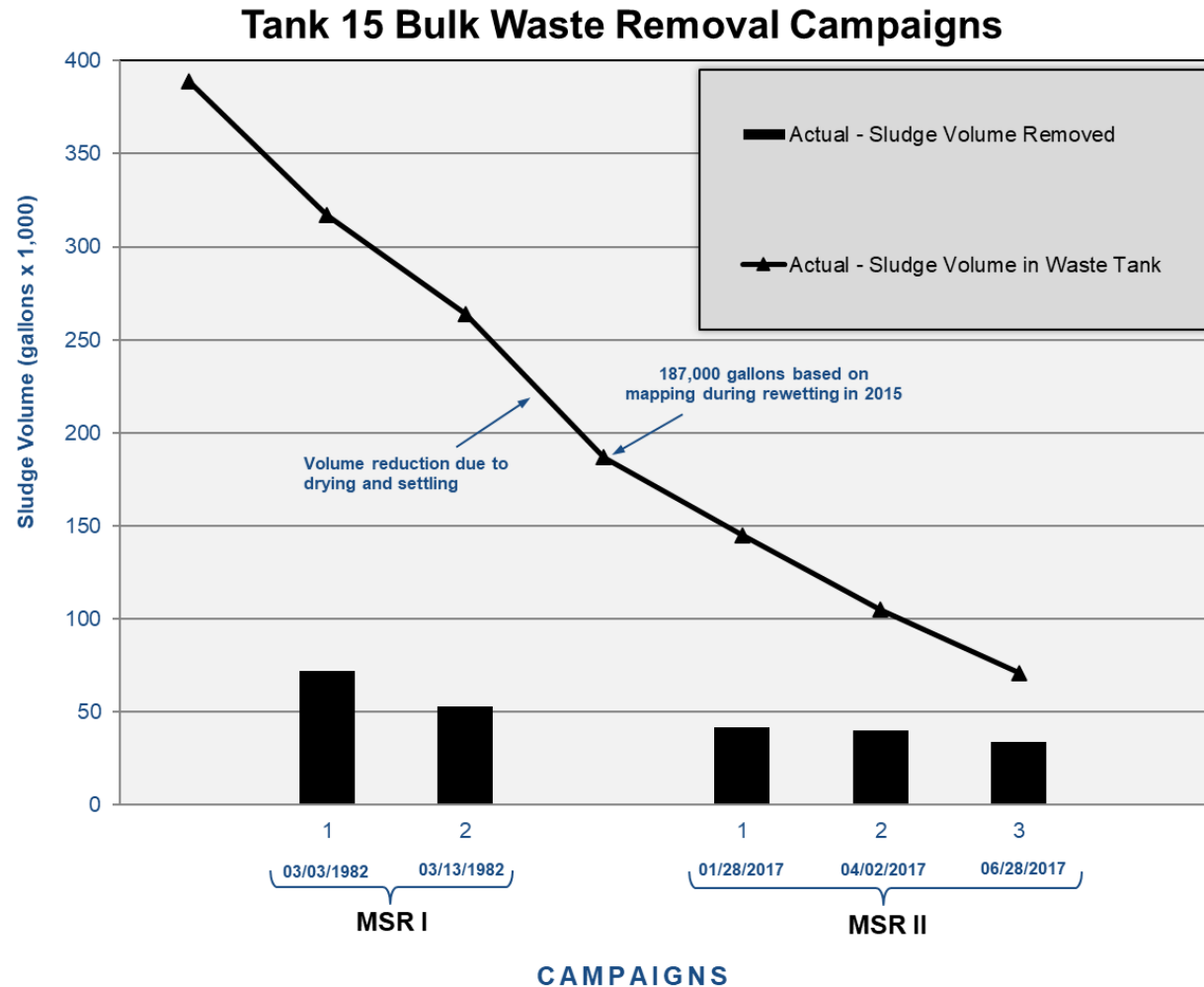
Before MSR II
No free liquid

After MSR II
Liquid Level ~17 inches



[SRR-CWDA-2017-00062]

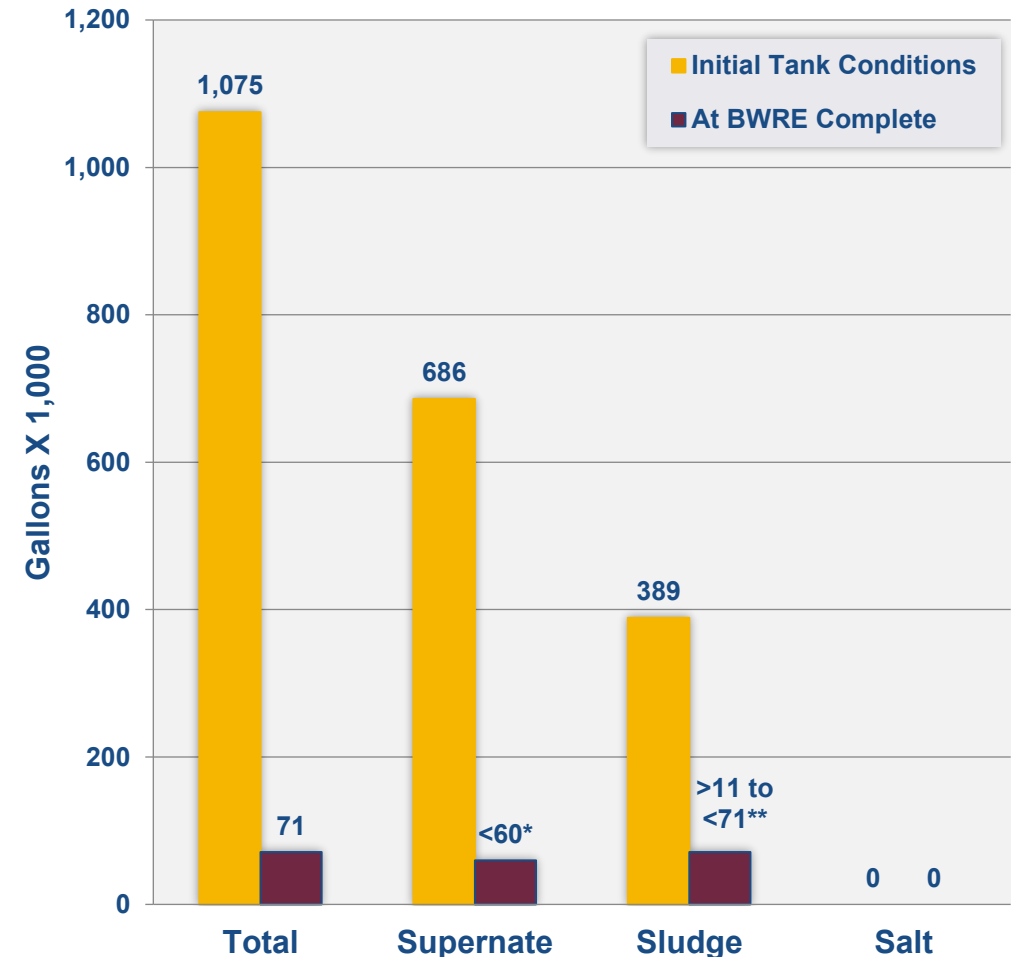
Sludge Removal Results – MSR I and II



[SRR-CWDA-2017-00062, DPSP-82-21-3, DPSP-83-17-3, U-ESR-H-00151 Rev. 4, U-ESR-H-00161]

Bulk Waste Removal Complete

- On September 21, 2017, BWRE declared complete by DOE
- Decision based on a diminishing effectiveness through each MSR II campaign, as well as a greater amount of solids being removed from Tank 15 than originally expected
- Efforts moved from the BWRE phase to Heel Removal

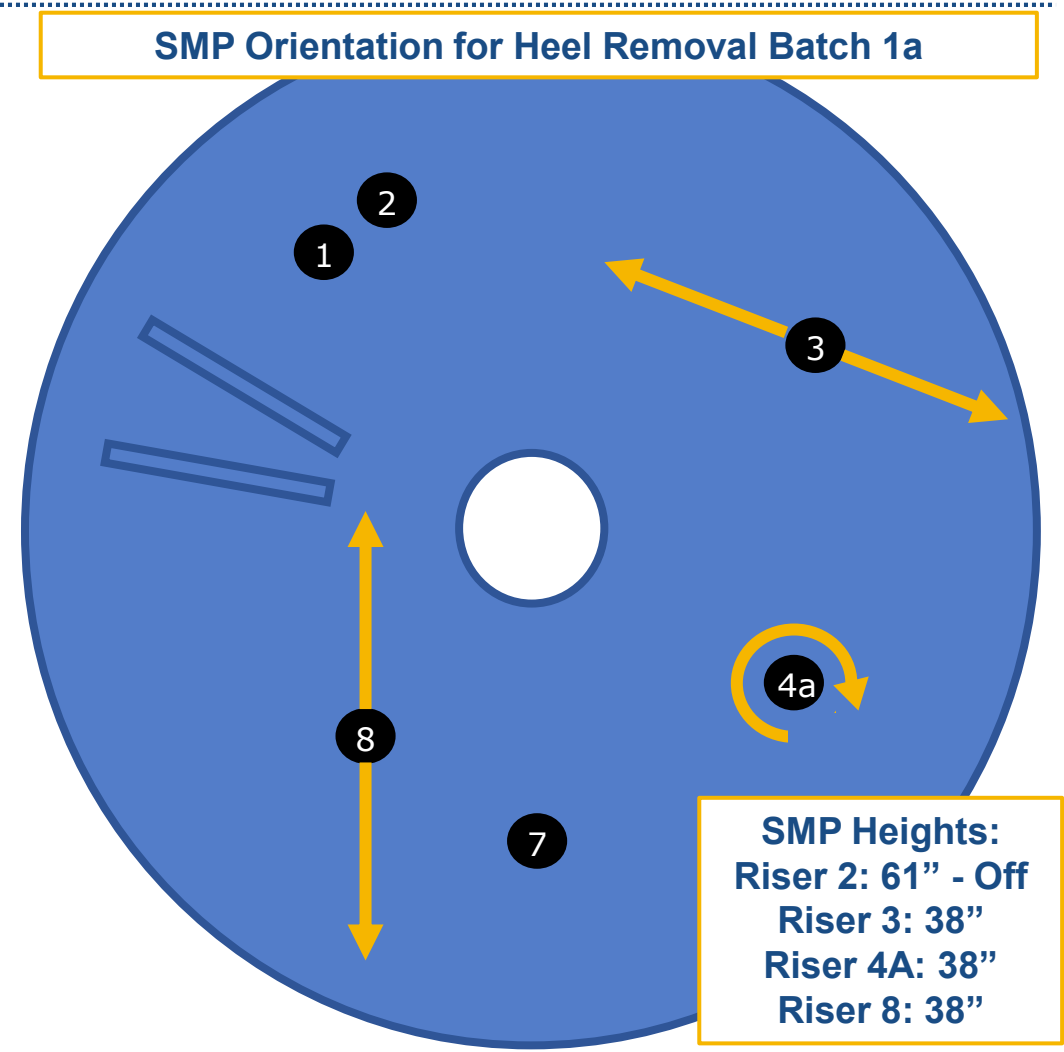


*With a liquid level of 17", the ~60,000 gallons of material is a combination of sludge and supernate.
 **Combined volume of sludge and supernate is 71,000 gallons; ~11,600 gallons of sludge estimated to be above the liquid level.

[SRR-CWDA-2017-00062, U-ESR-H-00124]

Heel Removal Batch 1a

- An extended indexing run was completed on September 28, 2017
- Goal was the reduction of the sludge mound under Riser 2
- SMPs in Risers 3, 4A, and 8 were operated for about 10 days
- A sounding taken at Riser 1 at the conclusion of the campaign indicated a reduction in the height of the mound under Riser 2 from 61 inches to 33.1 inches



[U-ESR-H-00124, U-ESR-H-00161, U-ESR-H-00185]

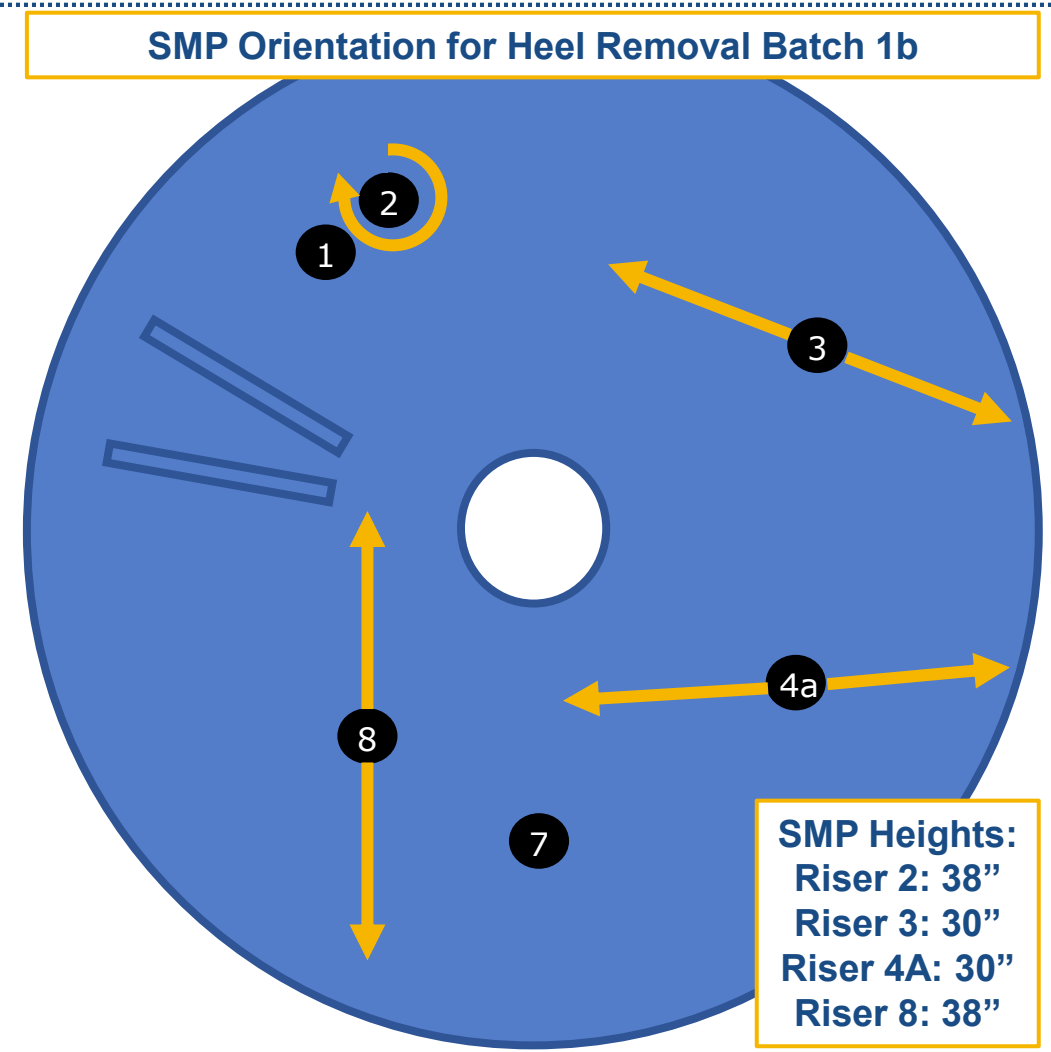
Suspension of Activities in Tank 15

- **Tank 15 activities were suspended following the extended indexing run**
 - *Sludge slurry not needed in the interim as Sludge Batch 10 was completed and Sludge Batch 11 was several years away*
- **Heel Removal efforts resumed in October 2022**
- **In preparation the failed Riser 2 SMP was replaced by the SMP in Tank 13 Riser 2A at a height of 38 inches**

[U-ESR-H-00193 Rev. 4]

Heel Removal Batch 1b

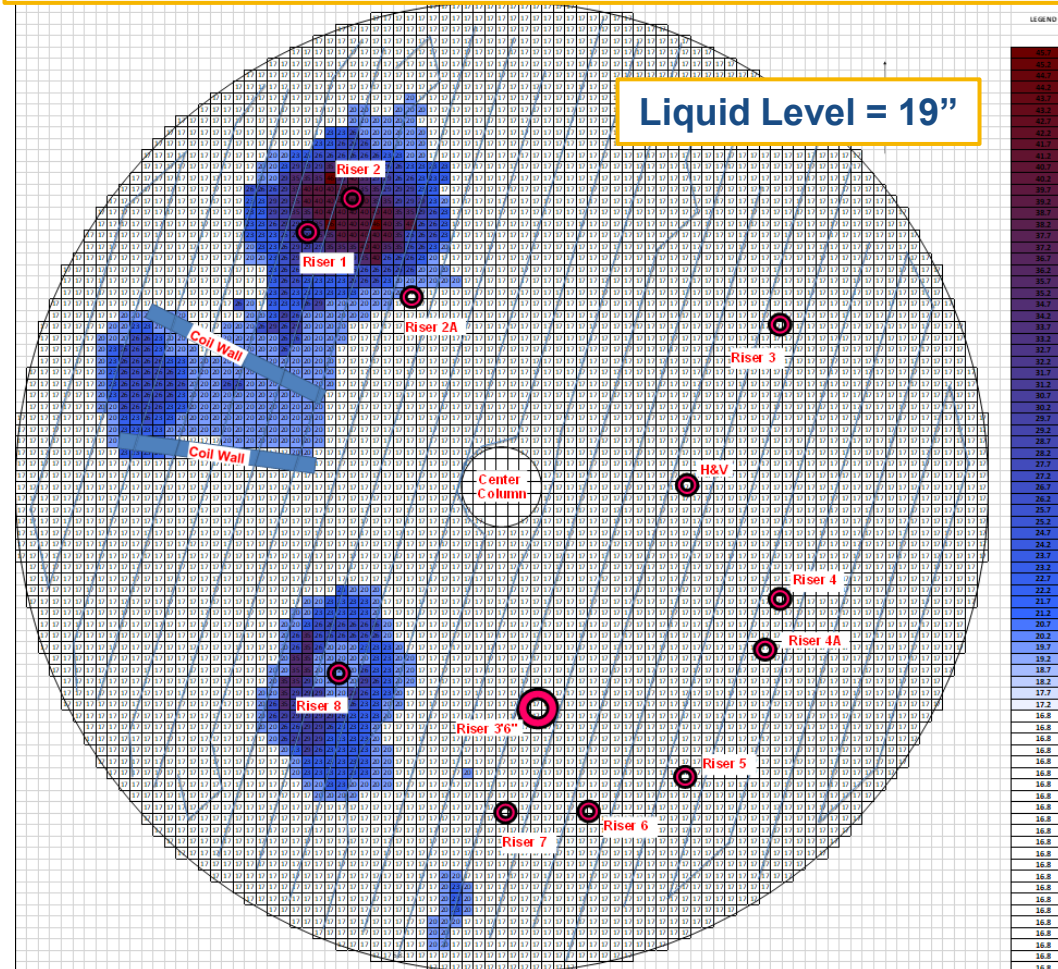
- Supernate from Tank 13 was added starting October 19, 2022, and used as the mixing media for the campaign
- SMP ran for a target of 10 days with the exception of the SMP in Riser 2, which due to faulting ran for 7.8 days
- Transfer from Tank 15 to Tank 13 completed on February 28, 2023
- Sludge slurry transferred (which included material from Campaigns 1a and 1b) weight percent insoluble solids estimated to be ~1.37%
- Approximately 9,000 gallons sludge estimated to have been removed, leaving a bounding sludge volume of 62,000 gallons



[U-ESR-H-00193 Rev. 4, U-ESR-H-00223]

Heel Removal Campaign 1 Conclusion

Residual Solids Map After Heel Removal Batch 1b
Plan View

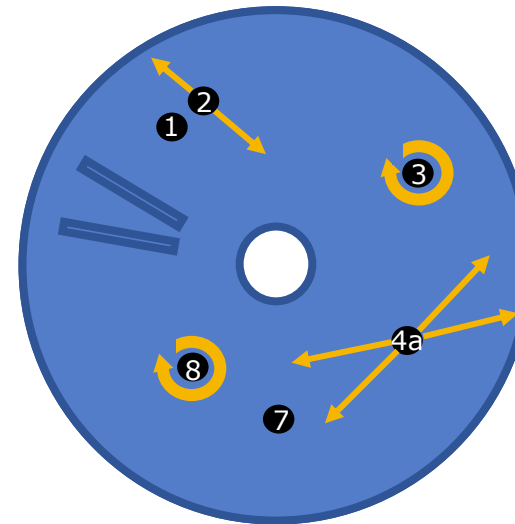


[U-ESR-H-00223]

Heel Removal Campaign 2

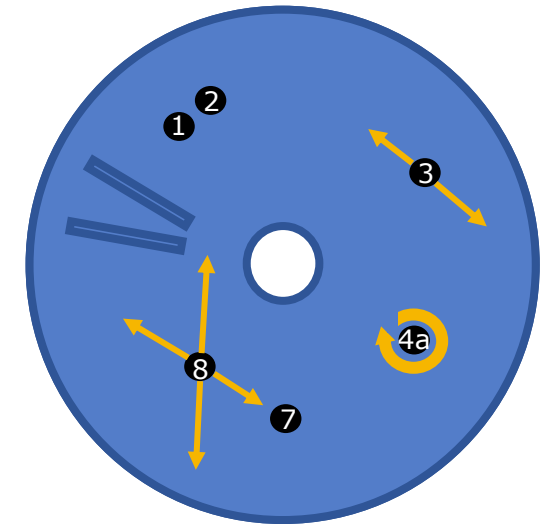
- Supernate from Tank 13 was added starting March 18, 2023, and used as the mixing media for the campaign
- Four SMPs were started up to begin the campaign, however, the Riser 2 SMP faulted after one day of operation. Campaign continued with three operational SMPs for a total of eleven days
- Two indexing strategies were used. Phase A during days 1-5 indexed SMPs in Risers 2 (before failure) and 4A. Phase B during days 6-10 indexed SMPs in Risers 3 and 8.
- Sludge slurry sampled and weight percent insoluble solids estimated to be ~0.8%

SMP Orientation for Heel Removal Campaign 2 Phase A



SMP Heights:
Riser 2: 38"
Riser 3: 18"
Riser 4A: 18"
Riser 8: 20"

SMP Orientation for Heel Removal Campaign 2 Phase B



SMP Heights:
Riser 2: 38"
Riser 3: 18"
Riser 4A: 18"
Riser 8: 20"

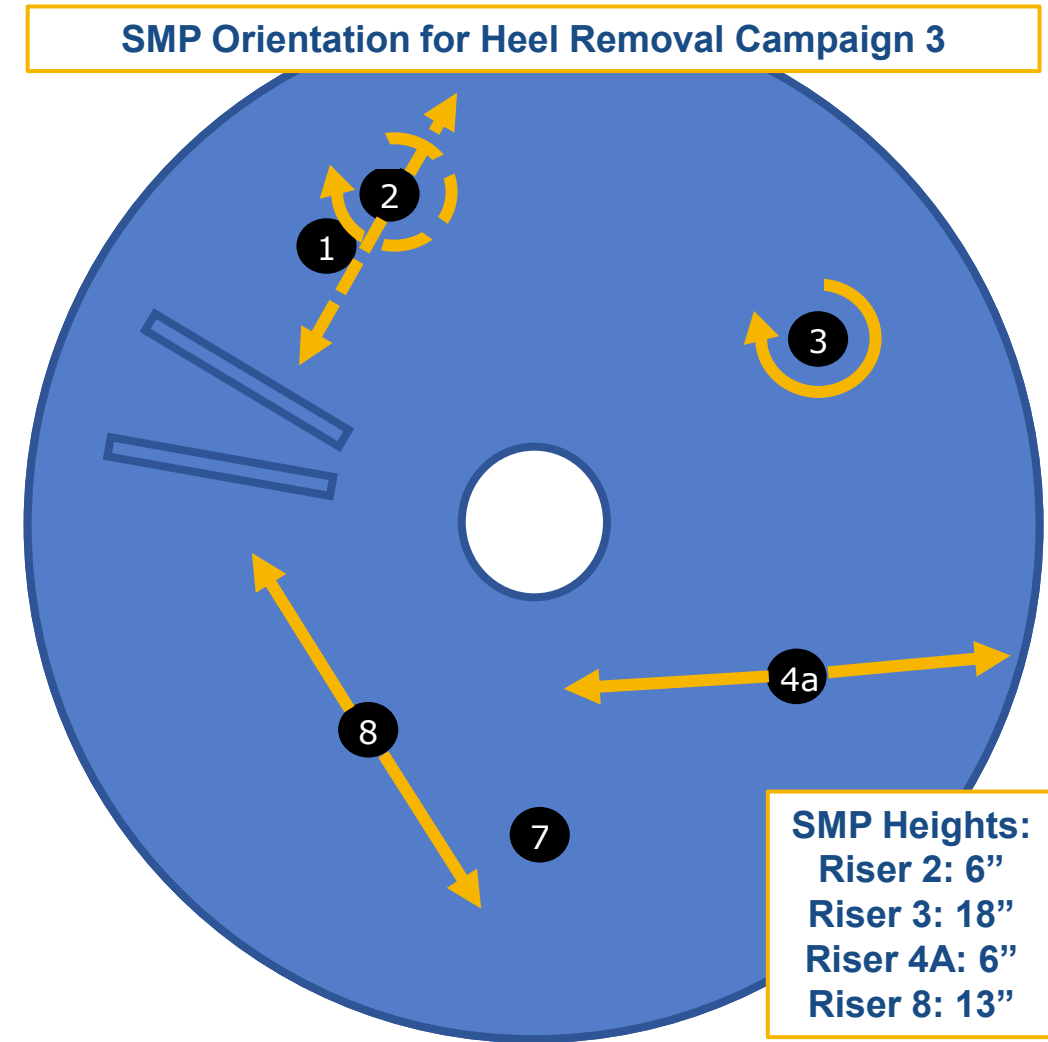
Heel Removal Campaign 2 Conclusion

- **After one day of operation the SMP in Riser 2 interlocked. Troubleshooting attempts were unsuccessful and the pump was declared “failed” likely due to seized bearings**
- **With the need to replace the Riser 2 SMP in conjunction with the low insoluble solids concentration in the slurry (~0.8 wt%), the decision was made to forgo the transfer of material out of Tank 15 at the conclusion of Heel Removal Campaign 2**
- **The failed SMP in Riser 2 was removed and a hydrolancing campaign was carried out to disperse the persistent mound under Risers 1 and 2 on June 1, 2023**
- **Replacement SMP installed in Riser 2 on June 7, 2023, in preparation for Heel Removal Campaign 3**

[U-ESR-H-00193 Rev. 4, SRNL-L3120-2023-00007]

Heel Removal Campaign 3

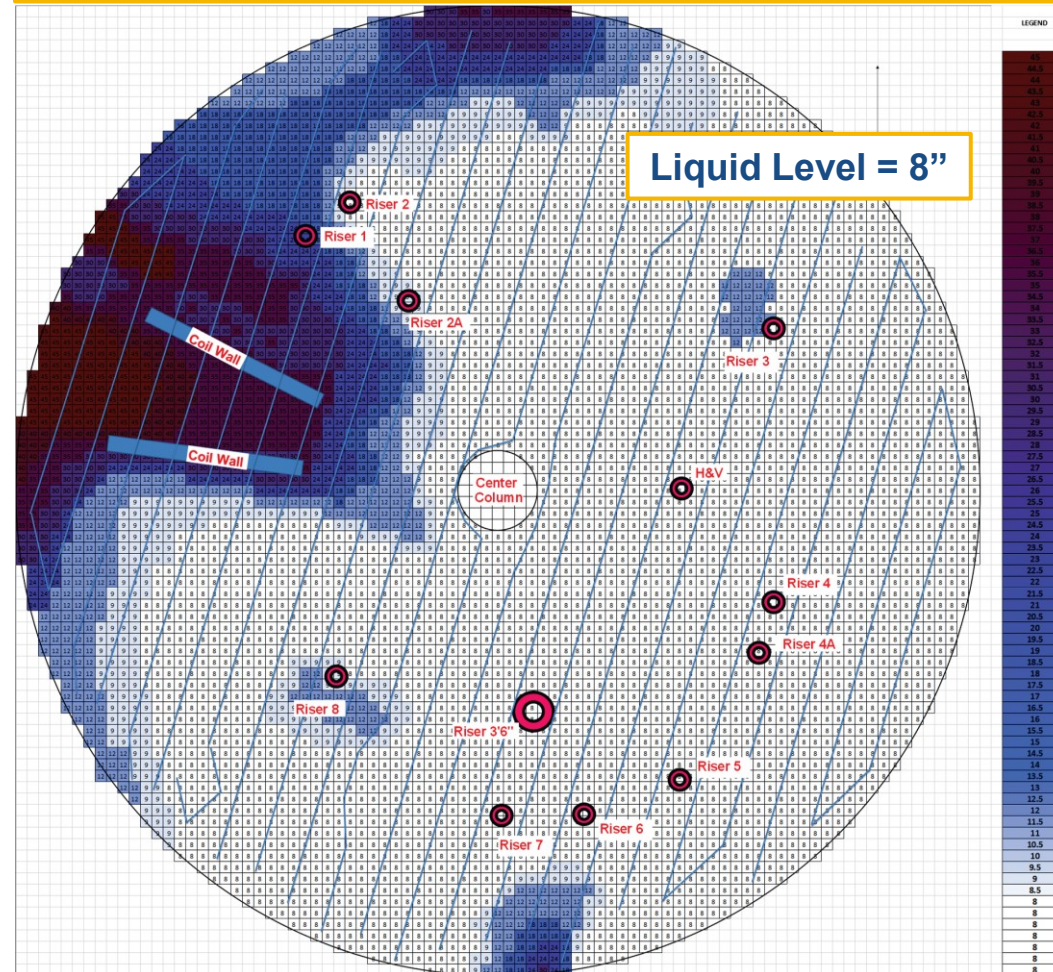
- No additional mixing media was added to Tank 15 for the campaign
- SMPs ran for a target of 10 days
 - For the first three days the Riser 2 SMP was incrementally rotated at a lower speed to slowly widen the mined well before indexing towards the valve house for days 4-5, while Riser 4A was indexed towards Riser 8, and Riser 8 was indexed towards the valve house.
 - After the indexing campaign, all SMPs were allowed to oscillate for days 6-10.
 - Multiple interruptions during the mixing campaign occurred, including power loss and reaching the SMP temperature limit
- Transfer from Tank 15 to Tank 13 was delayed due to failure of the STP and was completed on December 14, 2023.
- Sludge slurry transferred weight percent insoluble solids estimated to be ~0.7%
- Approximately 18,000 gallons sludge estimated to have been removed, leaving a bounding sludge volume of 44,000 gallons



[U-ESR-H-00193 Rev. 4, U-ESR-H-00233]

Heel Removal Campaign 3 Conclusion

Residual Solids Map After Heel Removal Batch 3
Plan View

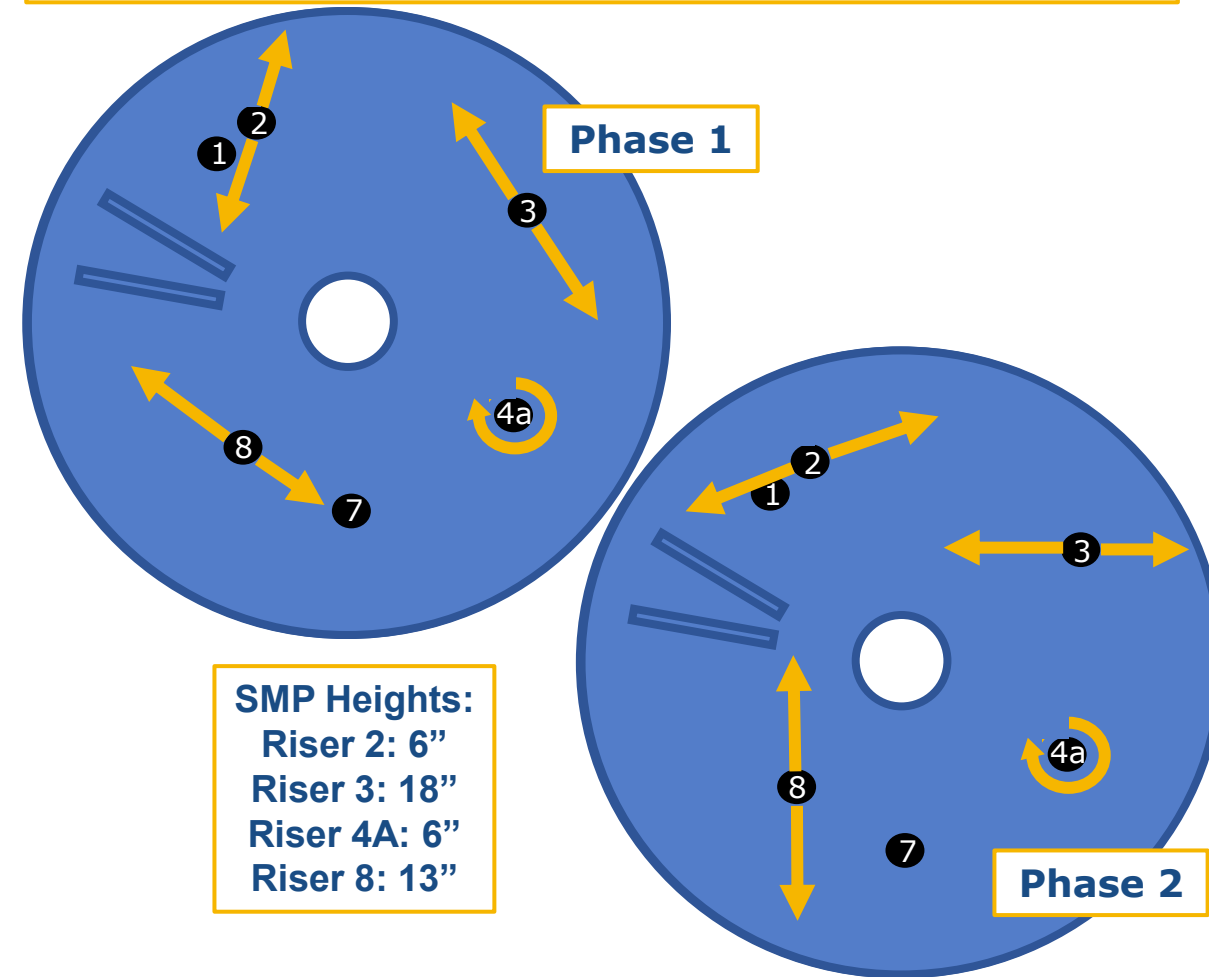


[U-ESR-H-00233]

Heel Removal Campaign 4

- Decanted material from Tank 13 was added to Tank 15 for the campaign
- SMPs ran for a target of 10 days
 - Two phases of indexing were performed in an effort to clear material collected behind the valve house. Risers 2, 3, and 8 SMPs were indexed in phase one orientation for the first four days, then orientation was changed for the second phase for days five through eight. The Riser 4A SMP was oscillated for the entirety of the campaign.
 - After both phases of the indexing campaign, all SMPs were allowed to oscillate for days 6-10.
- Transfer from Tank 15 to Tank 13 was completed on March 21, 2024.
 - Evidence from prior campaigns suggested solids were quickly settling, diminishing the effectiveness of solids removal during transfer.
 - The SMPs oscillated for 20 hours before the transfer began. Once transfer began Risers 2 and 3 SMPs were indexed towards the western mound for the first 36 hours, while Risers 4A and 8 continued to oscillate. After 36 hours, all SMPs (with the exception of Riser 2, which failed about 18 hours into the transfer) were set to oscillating until the liquid level mandated pump operation be suspended.
- Sludge slurry transferred weight percent insoluble solids estimated to be <0.2%
- Approximately 2,000 gallons sludge estimated to have been removed, leaving a bounding sludge volume of 42,000 gallons

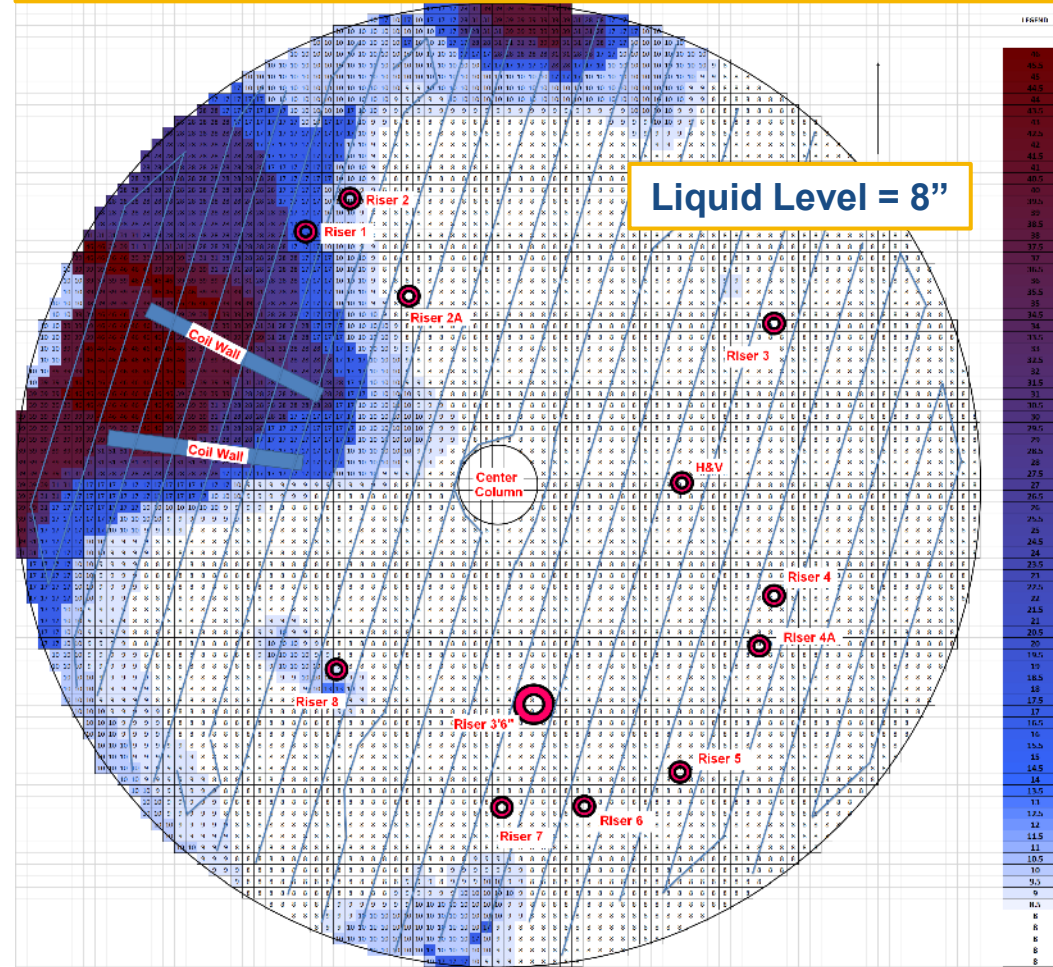
SMP Orientation for Heel Removal Campaign 4



[U-ESR-H-00193 Rev. 4, SRNL-L3130-2024-00007, U-ESR-H-00236]

Heel Removal Campaign 4 Conclusion

Residual Solids Map After Heel Removal Batch 4
Plan View



[U-ESR-H-00236]

Heel Removal Campaign 5

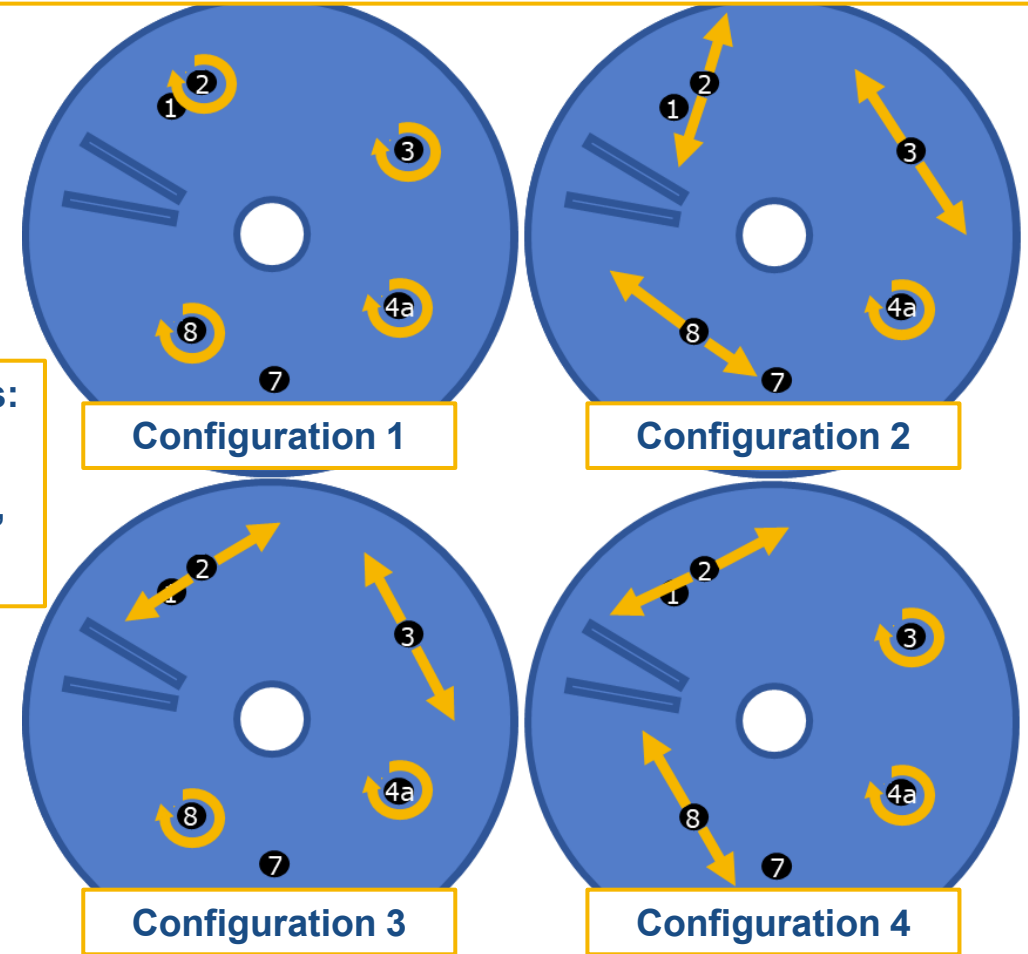
- **Heel Removal Campaign 4 showed a decrease in the effectiveness of traditional mixing campaigns in Tank 15**
 - *<0.2 wt% insoluble solids in sludge slurry vs. 1.37 wt% in Campaign 1*
- **In an effort to remove aluminum solids and alter the rheology of the remaining sludge, LTAD was implemented for Heel Removal Campaign 5**
 - *LTAD uses increased hydroxide concentration and temperature to dissolve aluminum solids*
 - *The temperature required for LTAD (>70°C) is above the normal operating limits for SMPs*
 - SMP operating procedures were modified to reflect the higher temperature limits
 - Cooling coils were isolated during start up and turned on and off to maintain tank temperature
- **Failing Riser 2 SMP was replaced prior to the start of Campaign 5**
 - *Hydrolancing performed before new SMP install to clear solids from the immediate area*

[U-ESR-H-00193, SRNL-L3130-2024-00007, U-ESR-H-00236]

Heel Removal Campaign 5

- ~108k gal decanted material from Tank 13 was added to Tank 15 for the campaign as well as ~58k gal sodium hydroxide (50 wt%) solution
- SMPs were operated in oscillation mode to raise the temperature to above 70°C
 - Risers 3 and 8 SMPs were declared failed
- Once temperature was above 70°C the temperature was maintained by using a combination of cooling coils and SMP operation for 39 days
 - Throughout this time period Risers 2 and 4A SMP operation followed four different turntable configurations, alternating approximately every three days
- Transfer from Tank 15 to Tank 13 was completed on August 18, 2024.
 - Riser 8 SMP was replaced
 - Risers 2, 4A, and 8 SMPs were operated during the transfer
- Sludge slurry transferred weight percent insoluble solids estimated to be 0.3%
- Aluminum concentration in the sludge slurry, 17,900 mg/L, indicated good dissolution
- Approximately 13,000 gallons sludge estimated to have been removed, leaving a bounding sludge volume of 29,000 gallons

SMP Orientation for Heel Removal Campaign 5

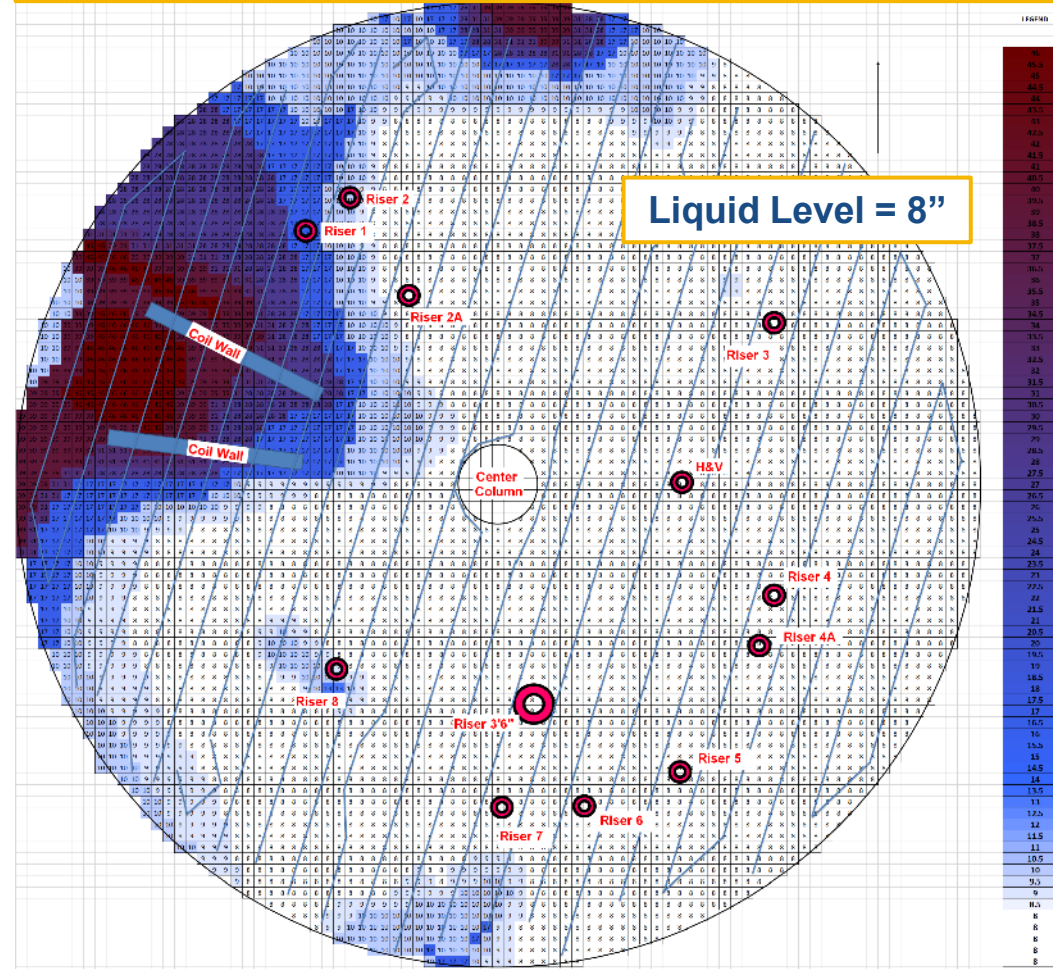


SMP Heights:
Riser 2: 6"
Riser 3: 18"
Riser 4A: 6"
Riser 8: 13"

[U-ESR-H-00193 Rev. 4, U-ESR-H-00193 Rev. 4 Add. 1, SRNL-L3130-2024-00017]

Heel Removal Campaign 5 Conclusion

Residual Solids Map After Heel Removal Batch 5
Plan View



[U-ESR-H-00244]

Tank 15 Annulus Cleaning

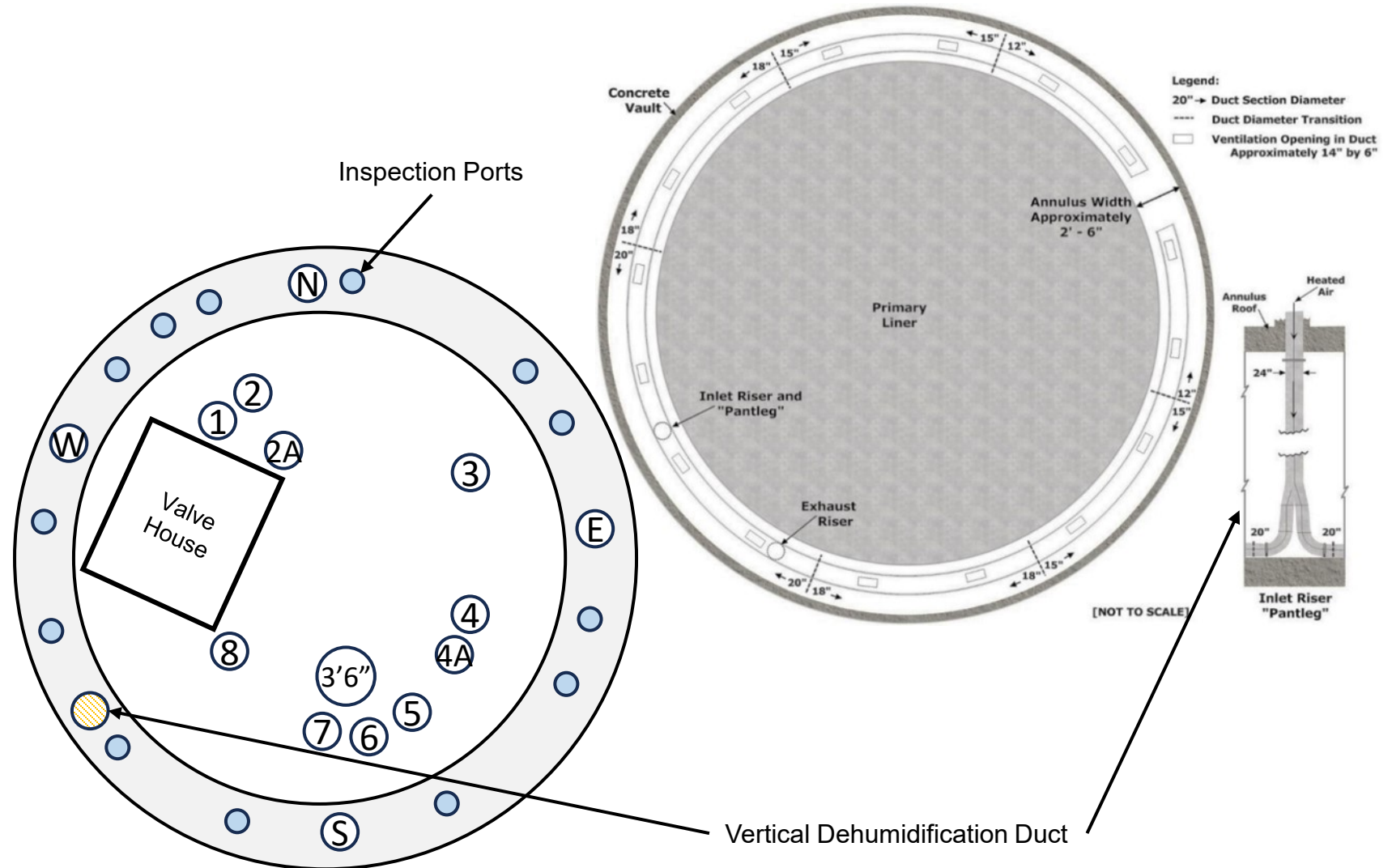
- To reduce impacts to the overall Liquid Waste System, annulus cleaning occurred between Heel Removal Campaigns 5 and 6
 - *Minimized new waste added to the Liquid Waste System by utilizing liquid from the annulus cleaning process to reach liquid levels in the primary tank required to operate SMPs*
- **Tank 15 Annulus State Before Cleaning**
 - *In 1972, two leak sites were viewed via the north annulus riser*
 - *Twelve new annulus ports added in 1973 that allowed nearly 100% inspection of the primary wall.*
 - *In total through 1973, 15 leak sites were identified contributing to 11 salt accumulations*
 - *To date, 34 leak sites have been identified*



[DPSPU-77-11-26, C-ESR-G-00003, SRMC-STI-2024-00076]

Tank 15 Riser Access

- **Primary access**
 - Ten 24-inch risers
 - One 42-inch central riser
- **Annulus access**
 - Four 24-inch risers
 - Tank 15 has an additional twelve 6-inch risers added as inspection ports



Tank 15 Annulus Before Cleaning*

*Pictures of Tank 15 annulus taken in June 2024

East Riser Facing South



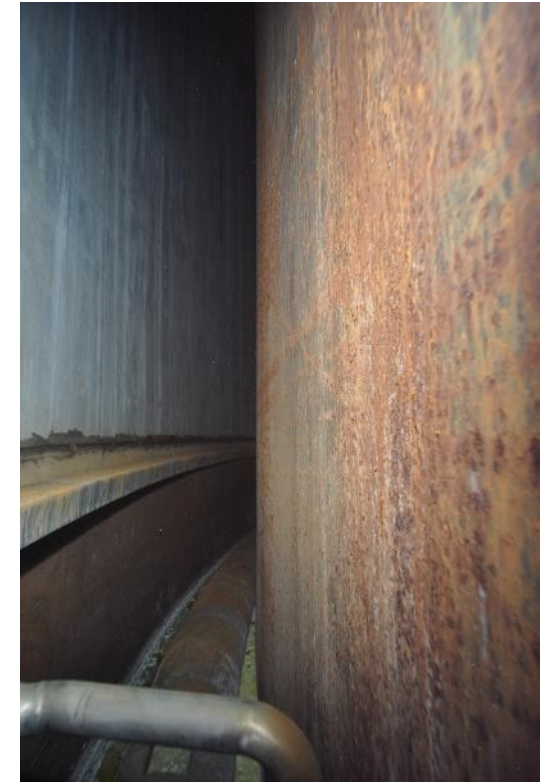
East Riser Facing North



West Riser Facing South



West Riser Facing North



Tank 15 Annulus Before Cleaning*

*Pictures of Tank 15 annulus taken in June 2024

North Riser Facing East



North Riser Facing West



South Riser Facing East



South Riser Facing West



Annulus Cleaning

- **Batch #1**

- 5,000 gallons of water added into the annulus via water addition downcomer
 - Salt in annulus pan submerged
- 10 day soak period
- Liquid level in the annulus after A-P transfer – 11 inches

- **Batch #2**

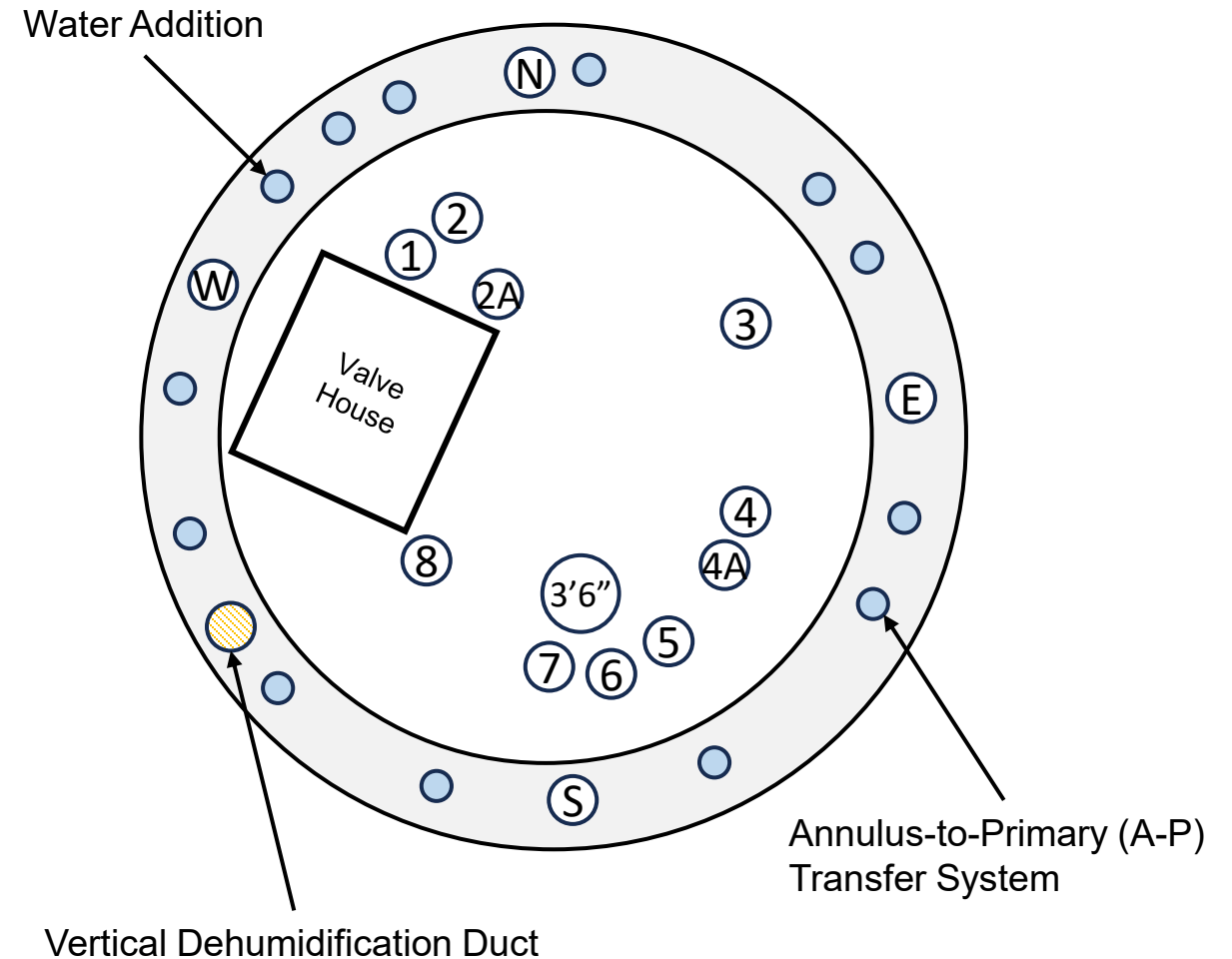
- 5,000 gallons of water added into the annulus via water addition downcomer
- 1.5 day soak period
- Liquid level in the annulus after A-P transfer – 11 inches

- **Batch #3**

- 5,000 gallons of water added into the annulus via water addition downcomer
- 1.5 day soak period
- Liquid level in the annulus after A-P transfer – 11 inches

- **Batch #4**

- 5,000 gallons of water added into the annulus via water addition downcomer
- 2 day soak period
- Liquid level in the annulus after A-P transfer – 10.43 inches



Tank 15 Annulus Cleaning

IP-107 Before/After



IP-207 Before/After



Tank 15 Annulus Cleaning

- **Based on results of annulus camera inspections, annulus cleaning considered complete and Heel Removal Campaign 6 initiated**
- **100% annulus inspection performed after Campaign 6 to verify conditions throughout**

Heel Removal Campaign 6

- **Heel Removal Campaign 6 utilized a water addition rather than the decanted material from Tank 13 used in previous campaigns**
 - *Sludge solids samples collected prior to Campaign 5 contained levels of Iodine(I)-129 that could impact the ability to meet performance objectives*
 - *I-129 was expected to be in readily soluble forms within the sludge*
 - *Water was added to Tank 15 as part of a heel washing effort to remove soluble I-129 and reduce the overall radioactive dose impact of the remaining sludge within Tank 15.*
- **The STP was replaced with a Dewatering STP capable of bringing the final liquid level lower than previous campaigns had achieved, allowing for a more accuracy during the tank mapping**

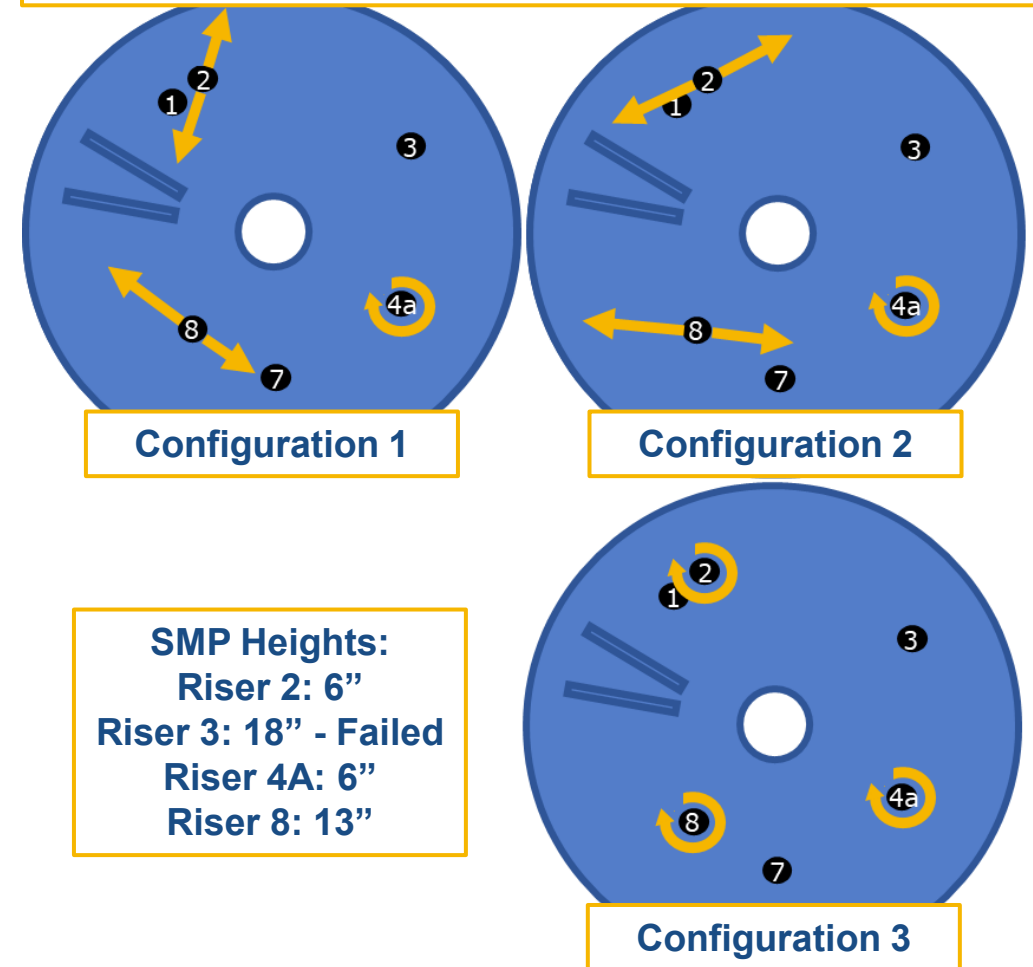
[U-ESR-H-00193 Rev. 4 Add. 2, SRNL-L3130-2024-00017]

Heel Removal Campaign 6

- ~236k gal water was added to Tank 15 for the campaign
- **SMPs ran for a target of 10 days**
 - *Two phases of indexing were performed in an effort to clear material collected behind the valve house. Risers 2 and 8 SMPs were indexed in phase one orientation for the first three days, then orientation was changed for the second phase for days four through six. The Riser 4A SMP was oscillated for the entirety of the campaign.*
 - *After both phases of indexing, all SMPs were placed in configuration three and allowed to oscillate for the remainder of the campaign*
- **Transfer from Tank 15 to Tank 13 using the installed STP brought the liquid level to 7.5"**
 - *Risers 2, 4A, and 8 SMPs were operated during the transfer*
- **The STP was removed and replaced with a Dewatering STP, allowing the liquid level to be reduced to 3"***
- **Mapping of the primary tank involving the use of a drone for the first time was performed**
- **Approximately 17,000 gallons sludge estimated to have been removed, leaving a bounding sludge volume of <12,000 gallons**

*Radar initially indicated a final liquid level of 5", however mapping showed a liquid level of 3". This discrepancy is due to the effect of the horizontal cooling coils and bends in vertical coils at the bottom of the tank.

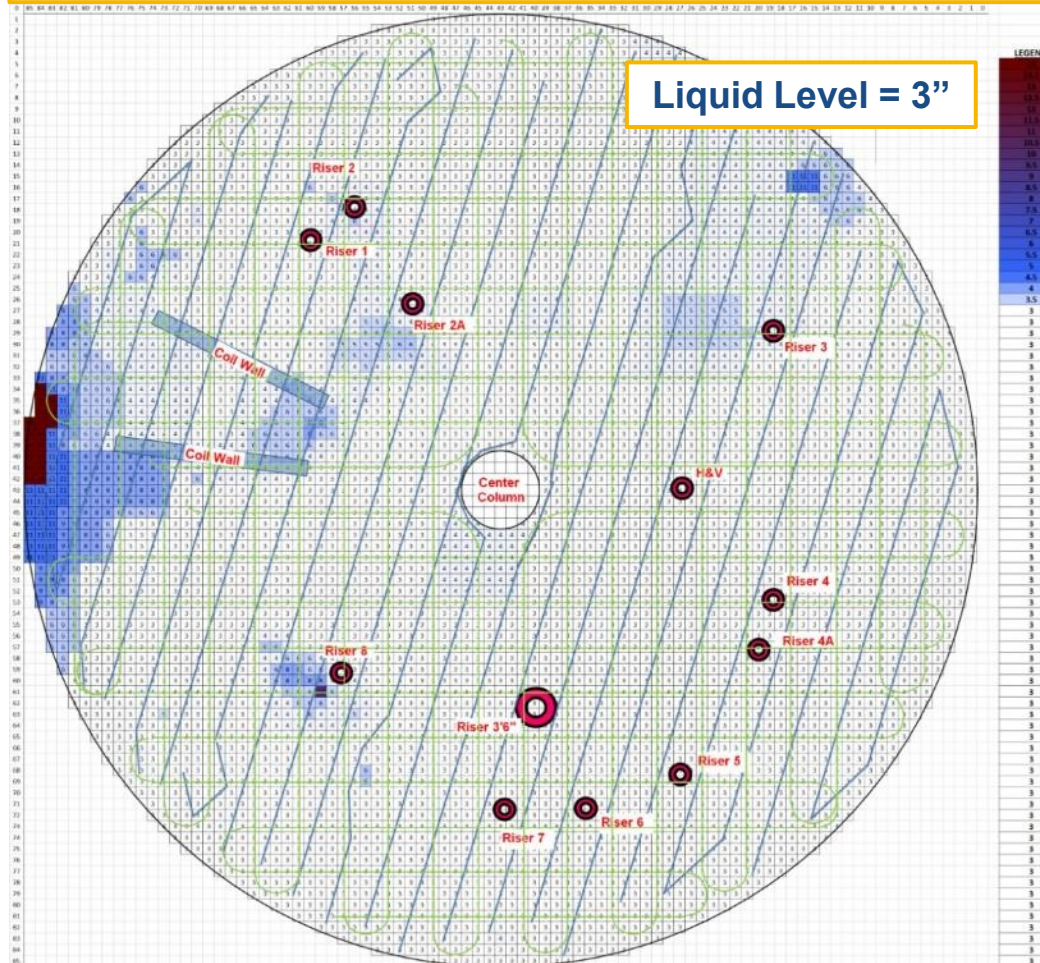
SMP Orientation for Heel Removal Campaign 6



[U-ESR-H-00193 Rev. 4 Add. 1, U-ESR-H-00193 Rev. 4 Add. 2, U-ESR-H-00246]

Heel Removal Campaign 6 Conclusion

Residual Solids Map After Heel Removal Batch 6
Plan View



[U-ESR-H-00246]

Heel Removal Campaign 7

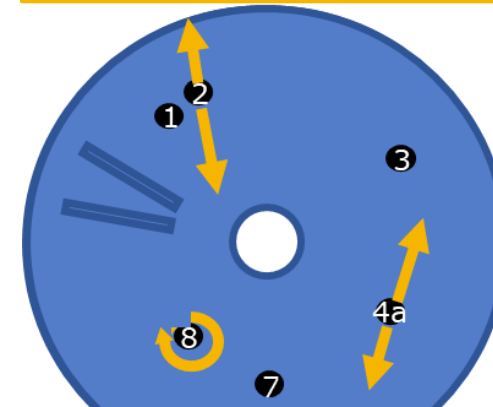
- **Heel Removal Campaign 7 followed a feed and bleed approach to remove maximum solids from the tank**
 - *Previous waste removal operations indicate that sludge solids settle out of suspension quickly following cessation of pump operations*
 - *To keep solids suspended in the supernate during the transfer out of Tank 15, Campaign 7 used simultaneous transfers between Tank 15 and Tank 13 allowing the SMPs to continue mixing during the transfer*

[U-ESR-H-00193 Rev.4 Add. 2]

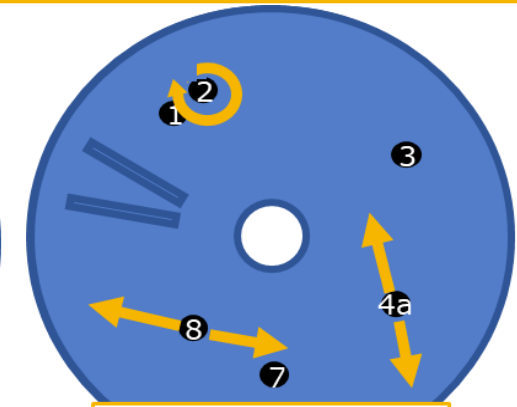
Heel Removal Campaign 7

- ~440k gal water was added to Tank 15 for the campaign
- **SMPs ran for a target of 10 days**
 - *Three phases of indexing were performed to move material collected behind the valve house and the smaller accumulation behind the failed Riser 3 SMP. Pump orientations were also configured to limit potential damage to the dewatering STP. Pumps remained in each configuration for approximately three days before moving to the next.*
 - *After indexing, all operational SMPs were placed in an oscillating state to suspend slurried sludge before initiation of the feed and bleed transfers*
- **Simultaneous transfers from Tank 15 to Tank 13 using the installed Dewatering STP occurred with the Riser 2, 4A, and 8 SMPs still operating to remove maximum solids for 12 days**
- **A final Tank 15 to Tank 13 transfer took place, bringing the liquid level to 6.5”**
- **The primary tank was mapped using footage from both a standard camera inspection and a drone inspection**
- **Approximately 6,000 gallons sludge estimated to have been removed, leaving a bounding sludge volume of <6,000 gallons**

SMP Orientation for Heel Removal Campaign 7

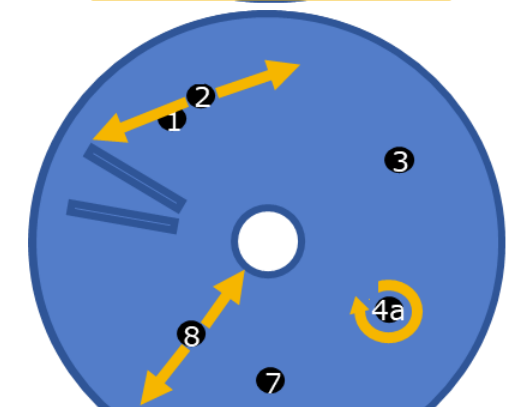


Configuration 1



Configuration 2

SMP Heights:
Riser 2: 6”
Riser 3: 18” - Failed
Riser 4A: 6”
Riser 8: 13”

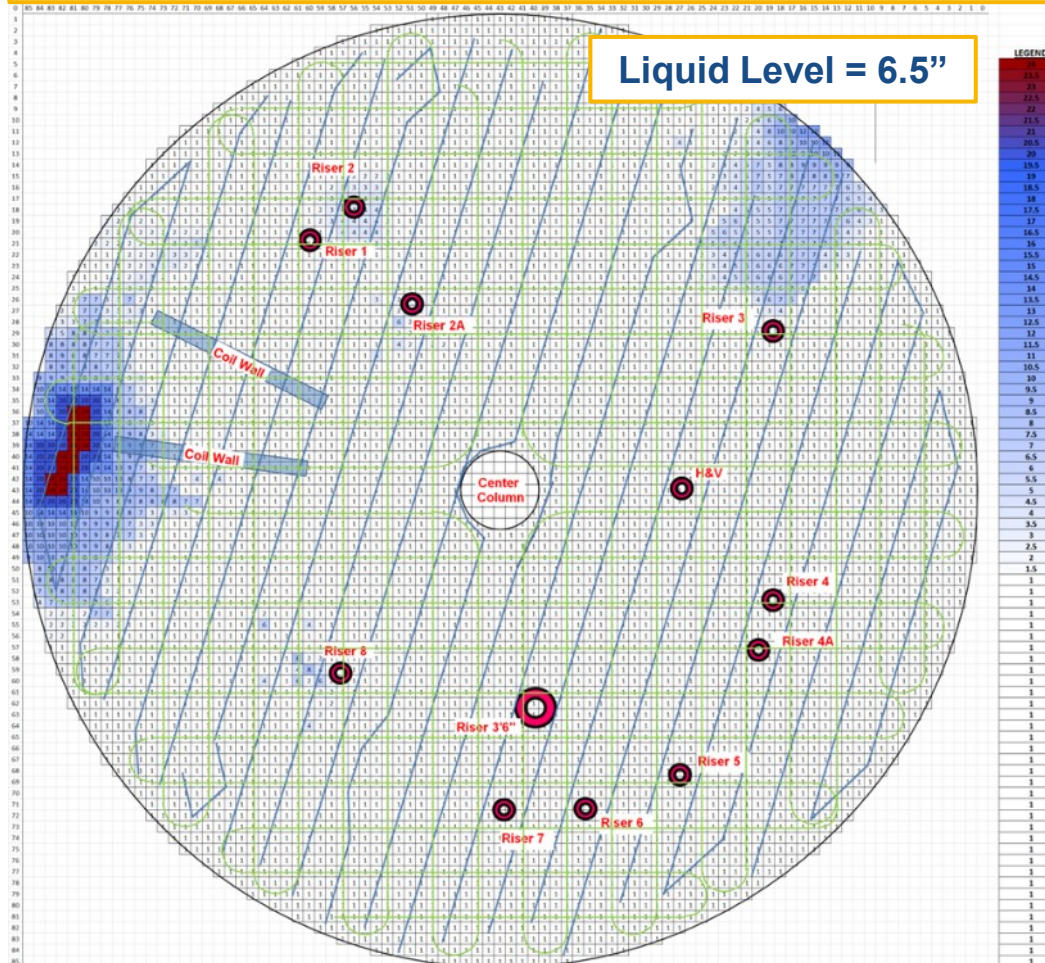


Configuration 3

[U-ESR-H-00193 Rev. 4 Add. 2, U-ESR-H-00255]

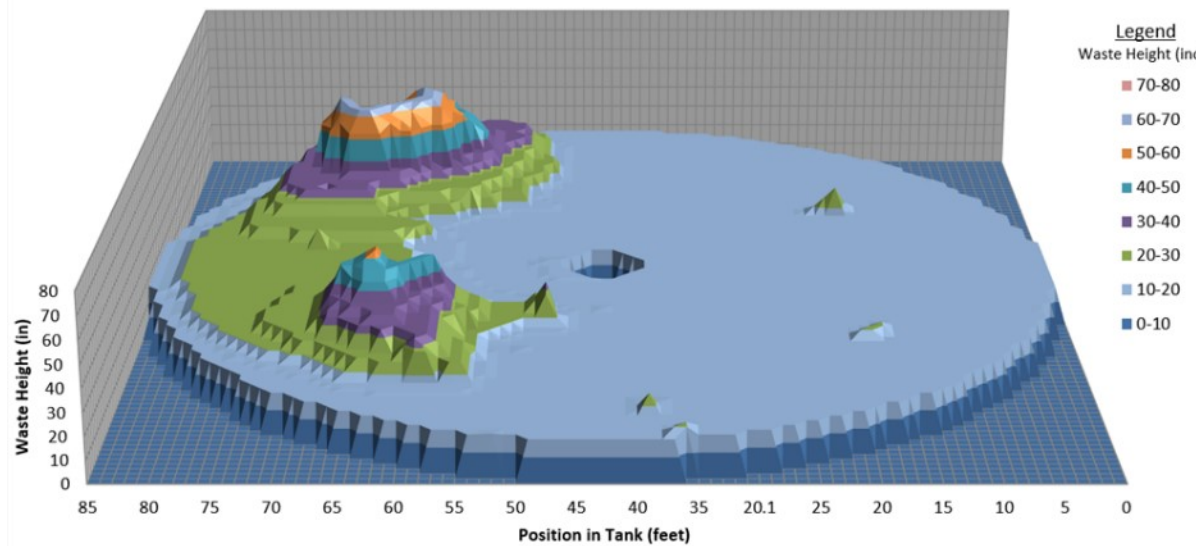
Heel Removal Campaign 7 Conclusion

Residual Solids Map After Heel Removal Batch 7
Plan View



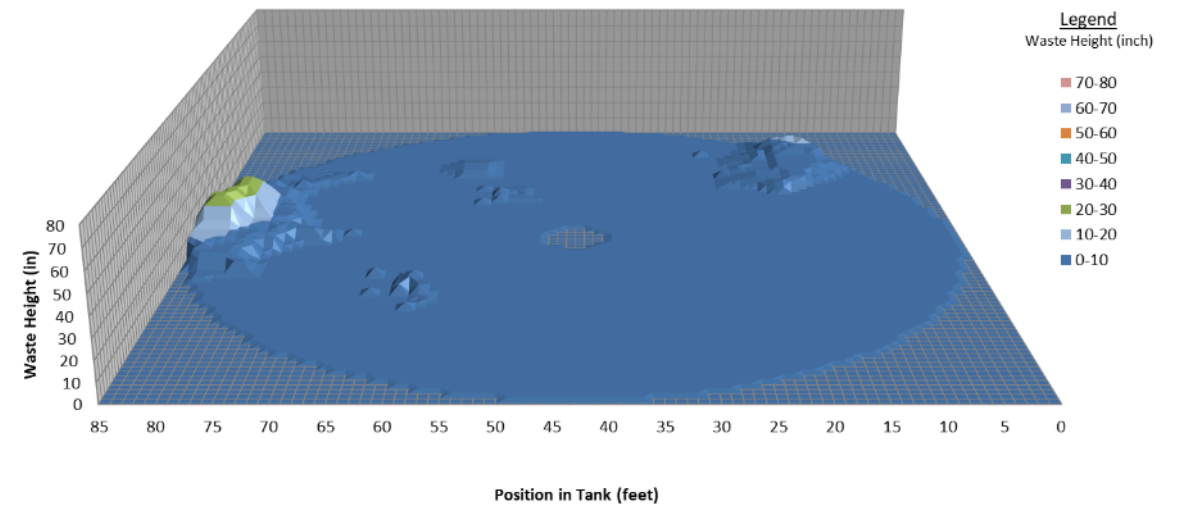
[U-ESR-H-00255]

Heel Removal - Conclusion



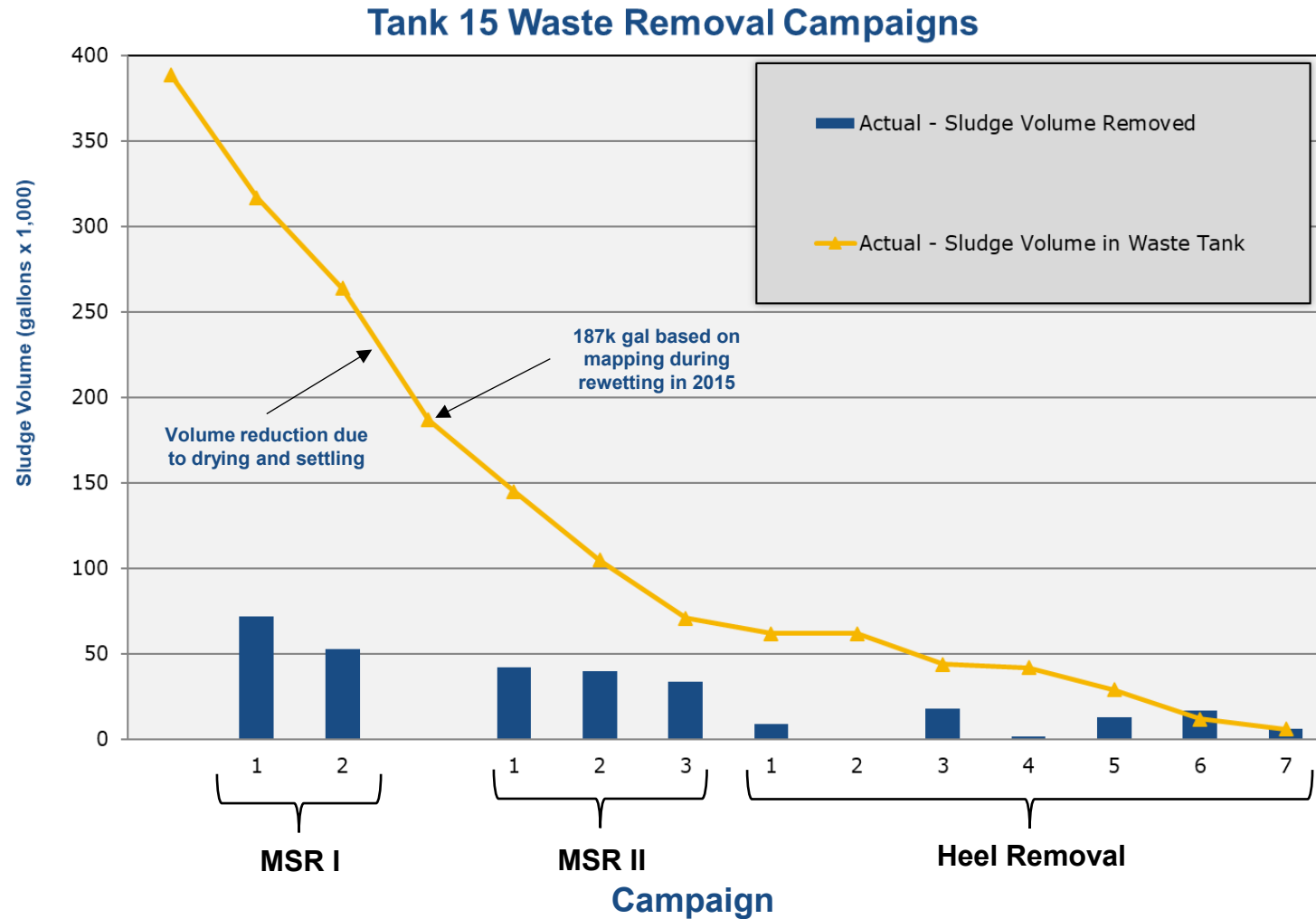
**Before Heel Removal
Liquid Level ~17 inches**

**After Heel Removal
Liquid Level ~6.5 inches**



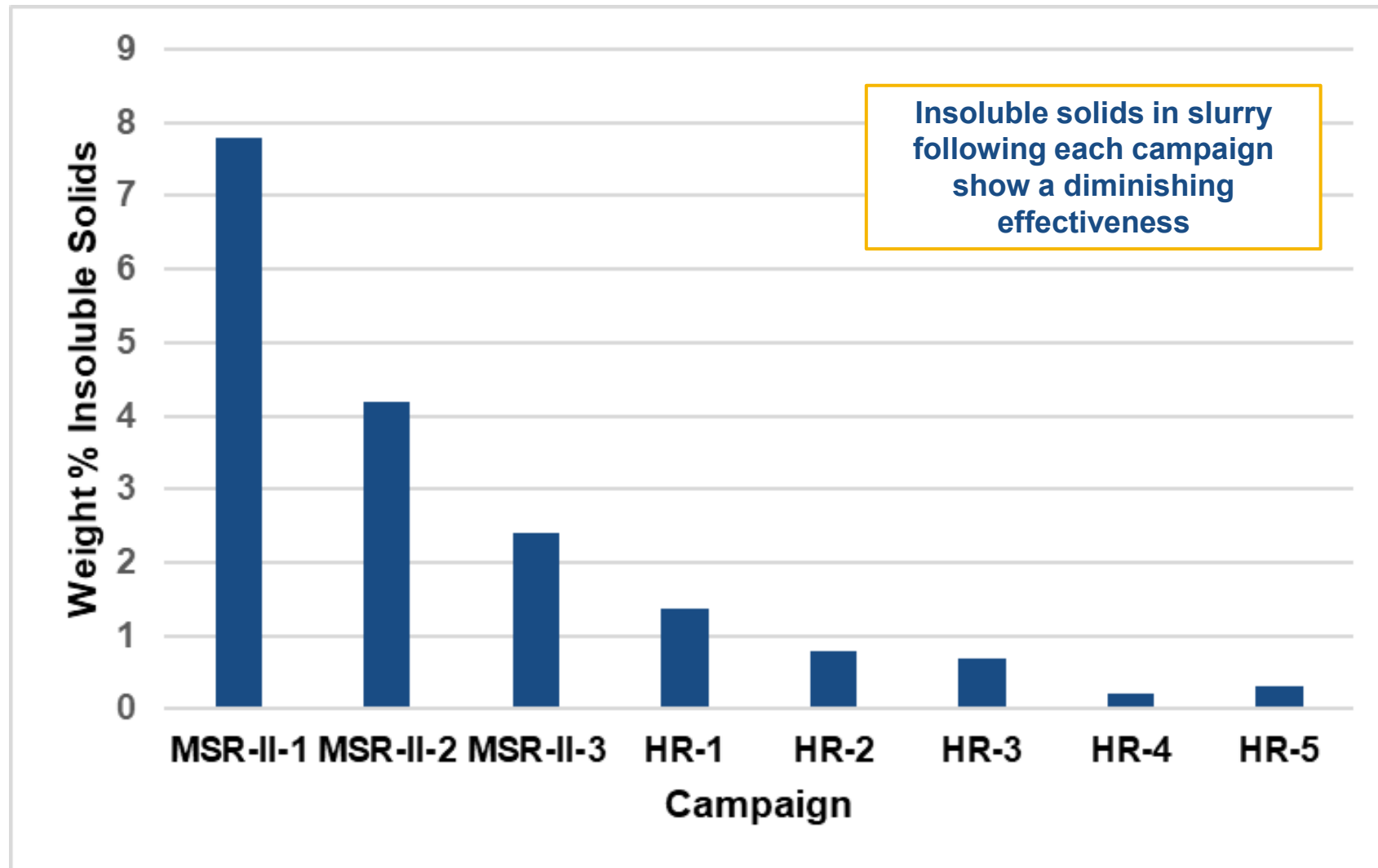
[SRR-CWDA-2017-00062, U-ESR-H-00255]

Sludge Removal Results



[SRR-CWDA-2017-00062, DPSP 82-21-3, DPSP 83-17-3, U-ESR-H-00151 Rev. 4, U-ESR-H-00161, U-ESR-H-00193, U-ESR-H-00223, U-ESR-H-00236, U-ESR-H-00244, U-ESR-H-00255]

Weight Percent Solids in Slurry



Current Status of Tank 15 – From Drone Inspection

North



North Tank Wall



Current Status of Tank 15 – From Drone Inspection

Northeast Quadrant from East



Northeast Quadrant from North



Current Status of Tank 15 – From Drone Inspection

Mound Behind Riser 3 SMP



Mound Behind Riser 3 SMP

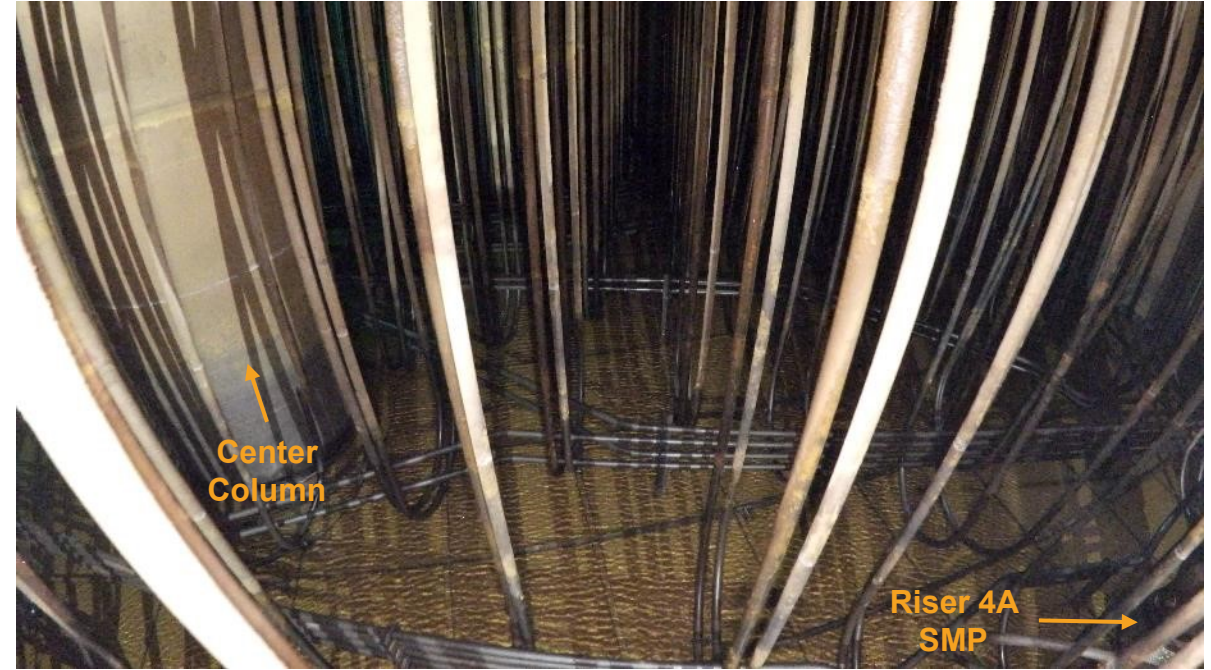


Current Status of Tank 15 – From Drone Inspection

East Tank Wall



East of Center Column



Current Status of Tank 15 – From Drone Inspection

Southeast Quadrant



Southeast



Current Status of Tank 15 – From Drone Inspection

South Tank Wall

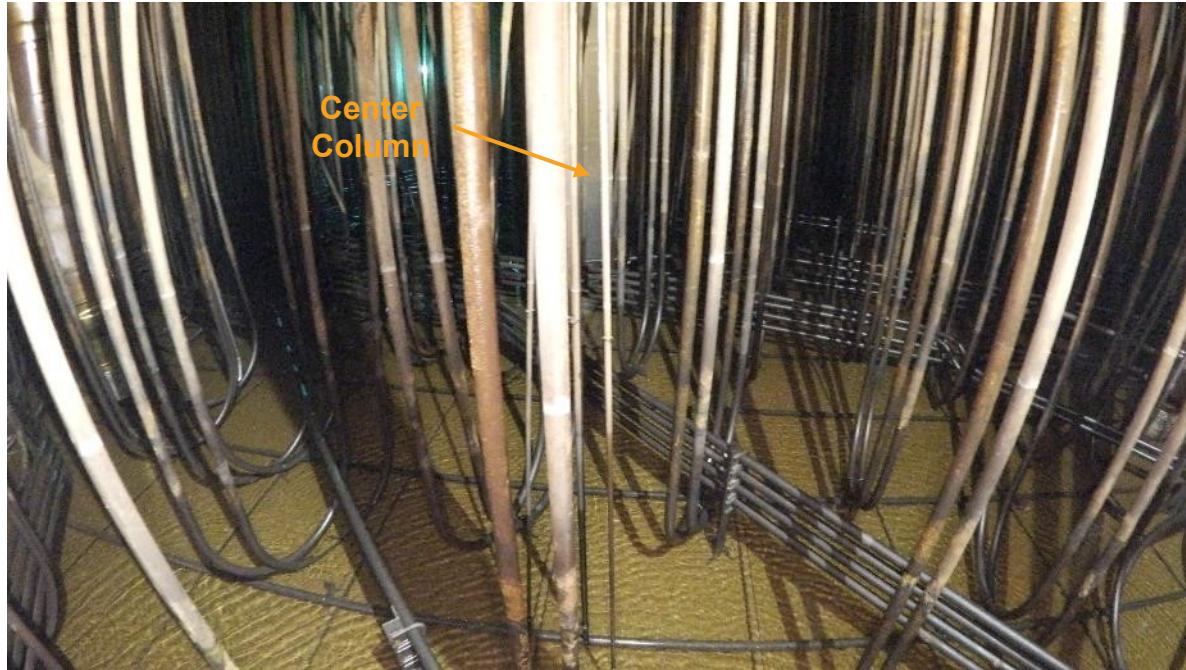


South from East of Center Column



Current Status of Tank 15 – From Drone Inspection

Center Column from South



Transfer Pump



Current Status of Tank 15 – From Drone Inspection

Riser 8 SMP

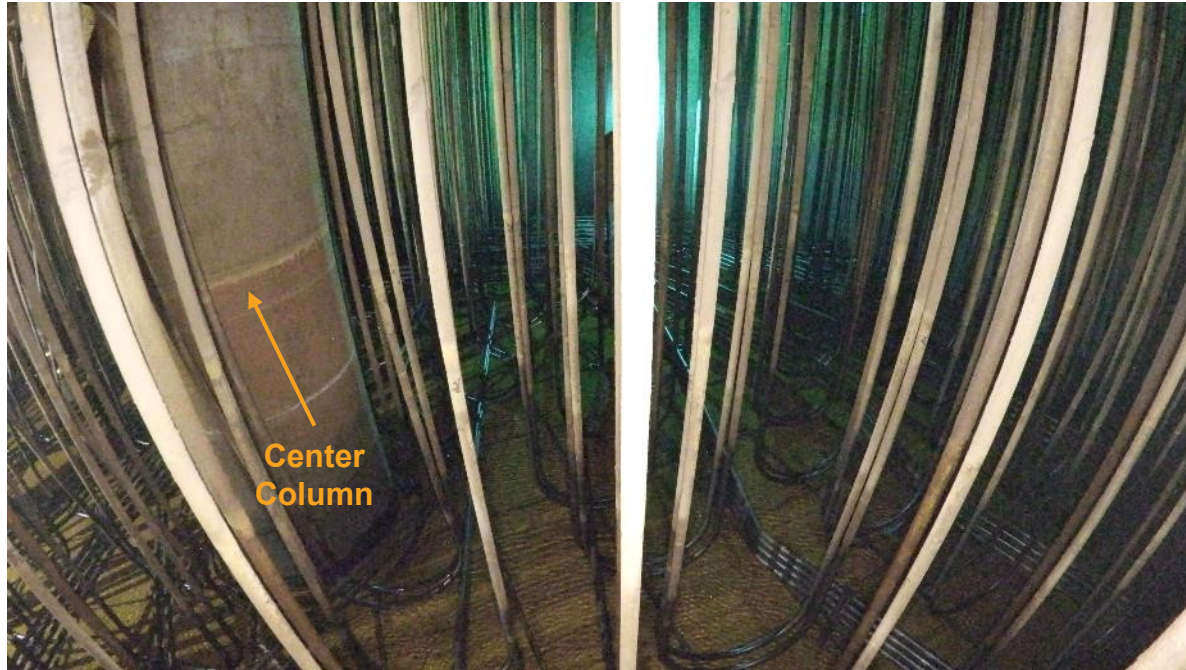


Southwest Quadrant to Center Column



Current Status of Tank 15 – From Drone Inspection

West



West



Current Status of Tank 15 – From Drone Inspection

Coil Mound from South



Coil Mound from South



Current Status of Tank 15 – From Drone Inspection

Coil Mound



Coil Mound



Current Status of Tank 15 – From Drone Inspection

Coil Mound



Coil Mound



Current Status of Tank 15 – From Drone Inspection

Coil Mound from North



Coil Mound from North



Current Status of Tank 15 – From Drone Inspection

Northwest Quadrant



Northwest of Center Column



Tank 15 Annulus

- **100% inspection of the Tank 15 annulus was possible**
- **Inspection of annular pan showed cleaning effectiveness consistent in all areas**
- **No significant change in solids level was seen in the last two annulus cleaning batches, the remaining solids are likely less soluble or insoluble salts**
- **Minimal salt accumulations were observed on the primary tank wall from previous leak sites**
- **Residual solids estimated to be less than four inches on average, ~1800 gallons**

Tank 15 Annulus

North Riser



Northeast Quadrant (IP171)



Tank 15 Annulus

East Riser



East Quadrant (IP207)



Tank 15 Annulus

Southeast Quadrant (IP242)



South Riser



Tank 15 Annulus

South Quadrant (IP10)



Southwest Quadrant (IP32)



Tank 15 Annulus

Southwest Quadrant (IP55)



West Quadrant (IP71)



Tank 15 Annulus

West Riser



Northwest Quadrant (IP107)



Tank 15 Annulus

Dehumidification Duct South Side



Dehumidification Duct West Side



Tank 15 Annulus

Material in Ventilation Duct



Tank 15 Annulus

Previous Leak Sites



References

- C-ESR-G-00003, Waltz, R., *SRS High Level Waste Tank Crack and Leak Information*, Savannah River Site, Aiken, SC, Rev. 23, June 2023.
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